# NUCLEAR SCIENCE ABSTRACTS

Volume 32 Number 12

Abstracts 27458-30484

**December 31, 1975**

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

# REPORT COLLECTIONS IN THE UNITED STATES

The libraries listed below purchase and maintain microfiche collections of ERDA and foreign reports that are abstracted in *NSA*. Their collections also include *NSA* and its indexes, ERDA's Technical Progress Reviews, ERDA-sponsored translations, conference proceedings published by ERDA, and various bibliographic tools. Most of these libraries have microfiche reader-printers or other photocopy facilities with which to reproduce enlarged copies from microfiche. Charges for reproduction services vary.

Report collections of ERDA reports in countries other than the United States are listed on the inside back cover.

**ALABAMA**
Auburn, Auburn University
Tuskegee Institute, Tuskegee Institute

**ARIZONA**
Tucson, University of Arizona

**CALIFORNIA**
Davis, University of California
Los Angeles, University of California
Santa Barbara, University of California

**COLORADO**
Boulder, University of Colorado

**DISTRICT OF COLUMBIA**
Washington, Library of Congress

**FLORIDA**
Gainesville, University of Florida

**GEORGIA**
Atlanta, Georgia Institute of Technology

**HAWAII**
Honolulu, University of Hawaii

**IDAHO**
Pocatello, Idaho State University

**ILLINOIS**
Urbana, University of Illinois

**INDIANA**
Lafayette, Purdue University

**IOWA**
Ames, Iowa State University

**KANSAS**
Manhattan, Kansas State University

**KENTUCKY**
Lexington, University of Kentucky

**MARYLAND**
Baltimore, Johns Hopkins University
College Park, University of Maryland

**MASSACHUSETTS**
Cambridge, Massachusetts Institute of Technology
Worcester, Worcester Polytechnic Institute

**MICHIGAN**
Ann Arbor, University of Michigan

**MISSISSIPPI**
State College, Mississippi State University

**MISSOURI**
Columbia, University of Missouri
Kansas City, Linda Hall Library

**NEW JERSEY**
Princeton, Princeton University

**NEW MEXICO**
Albuquerque, University of New Mexico

**NEW YORK**
Albany, New York State Library
Albany, State University at Albany
Ithaca, Cornell University
New York, Columbia University
Rochester, University of Rochester
Syracuse, Syracuse University

**NORTH CAROLINA**
Raleigh, North Carolina State University

**OHIO**
Cincinnati, University of Cincinnati
Cleveland, Cleveland Public Library
Toledo, University of Toledo

**OKLAHOMA**
Norman, University of Oklahoma

**PENNSYLVANIA**
Philadelphia, University of Pennsylvania
Pittsburgh, Carnegie Library
University Park, Pennsylvania State University

**PUERTO RICO**
San Juan, University of Puerto Rico

**SOUTH CAROLINA**
Columbia, University of South Carolina

**TENNESSEE**
Knoxville, University of Tennessee

**TEXAS**
Austin, University of Texas
College Station, Texas A & M University
Houston, Rice University

**UTAH**
Salt Lake City, University of Utah

**VIRGINIA**
Blacksburg, Virginia Polytechnic Institute
Charlottesville, University of Virginia

**WASHINGTON**
Pullman, Washington State University
Seattle, University of Washington

**WEST VIRGINIA**
Morgantown, West Virginia University

**WISCONSIN**
Madison, University of Wisconsin

ERDA reports so indicated in *Nuclear Science Abstracts* are offered for sale by National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

# NOTICE

A title page for Volume 32, Numbers 7–12, is included at the back of this issue for use in binding those issues.

# CORRECTIONS

NSA Vol. 32, No. 1, Abst. 12, line 3 should read: TRONS. Filss, P. Trans. Amer. Nucl. Soc.; 20: 341-343(Apr

NSA Vol. 32, No. 1, Personal Author Index, page 30, Filiss, P. should read: Filss, P.

Volume 32, Number 12, December 31, 1975

# NUCLEAR SCIENCE ABSTRACTS

*A semimonthly publication of the USERDA Office of Public Affairs*
*Published by the ERDA Technical Information Center*

*Nuclear Science Abstracts* provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Energy Research and Development Administration and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

The following organizations scan and abstract the nuclear science literature in their respective countries for input to the International Nuclear Information System of the International Atomic Energy Agency. By special agreement, the input to INIS is simultaneously sent to the ERDA Technical Information Center to enhance the timeliness of coverage of that literature in *Nuclear Science Abstracts*.

Atomic Energy of Canada Limited
Australian Atomic Energy Commission
Danish Atomic Energy Commission
Finnish Atomic Energy Commission
French Atomic Energy Commission
Japan Atomic Energy Bureau–Atomic Energy Research Institute
Commissie Nucleaire Informatieverzorging (Netherlands)
Institutt for Atomenergi (Norway)
Aktiebolaget Atomenergi (Sweden)
United Kingdom Atomic Energy Authority
Zentralstelle für Atomkernenergie-Dokumentation (West Germany)

Numerous organizations, societies, and publishers throughout the world provide *Nuclear Science Abstracts* with advance page-proof copy of their publications.

A list of the journals scanned regularly and the abbreviations used appears in the January 15 issue of *Nuclear Science Abstracts* and is supplemented in the July 15 issue. The January 15 issue also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

## HOW TO OBTAIN NUCLEAR SCIENCE ABSTRACTS

*Nuclear Science Abstracts* is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

*NSA* is issued in two volumes per calendar year, one beginning January 15, the other July 15. Each volume consists of twelve issues.

For the two 12-issue volumes, the annual subscription rate is $121.05 for domestic subscribers and $151.35 for foreign subscribers. A single issue costs $5.05 domestic rates or $6.26 foreign rates. Domestic rates apply to the United States, Canada, Mexico, and Central and South American countries except Argentina, Brazil, Guyana, French Guiana, Surinam, and British Honduras.

Indexes are cumulated for each volume, i.e., on a six-month volume basis. If purchased on an annual subscription basis the two volume indexes are priced at $44.40 for domestic subscribers and $55.50 for foreign subscribers.

The volume indexes are also sold separately. Each volume index is priced on the basis of pagination at the time of publication.

Previous *NSA* cumulative indexes are available:

From Johnson Reprint Corporation, 111 Fifth Avenue, New York, N. Y. 10003:

**Vols. 1–4, Subjects and Authors (1948–1950), $30.00.**

From Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830:

**Vols. 5–10, Subjects and Authors (1951–1956), $5.25.**
**Vols. 11–15, Subjects (1957–1961), $19.00.**
**Vols. 11–15, Personal Authors (1957–1961), $14.25.**
**Vols. 11–15, Corporate Authors (1957–1961), $2.50.**

From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402:

**Vols. 16–20, Subjects (1962–1966), $36.00.**
**Vols. 16–20, Personal Authors (1962–1966), $22.50.**
**Vols. 16–20, Corporate Authors (1962–1966), $3.75.**
**Vol. 26, Subjects and Authors (1972), $37.75.**
**Vol. 27, Subjects, Authors, and Report Numbers (Jan.–June 1973), $16.90.**
**Vol. 28, Subjects and Authors (July–Dec. 1973), $18.55.**
**Vol. 29, Subjects and Authors (Jan.–June 1974), $20.10.**
**Vol. 30, Subjects, Authors, and Report Numbers (Vols. 29 and 30) (July–Dec. 1974), $27.35.**
**Cumulative Report Number Index, Vols. 1–15 Revised, $4.00.**
**Cumulative Report Number Index, Vols. 16–20 Revised, $5.50.**
**Cumulative Report Number Index, Vols. 21–28, $9.35.**

From Xerox University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106:

**Vols. 21–25, Subjects, Authors, and Corporate Authors (1967–1971), $195.00.**

*Nuclear Science Abstracts* is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Government agencies may obtain *NSA* free of charge. Inquiries should be directed to the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

*Nuclear Science Abstracts* is also available on 16-mm and 35-mm microfilm in reel or cartridge from Princeton Microfilm Corporation, Alexander Road, Princeton, New Jersey 08540. The cost of Vols. 1–26 (1948–1972) including *Abstracts of Declassified Documents* (1947–1948) is $730.00. The indexes for *Nuclear Science Abstracts* Vols. 1–26 (1948–1972) are also available for $385.00. The cost of each volume (six months) of *NSA* and its indexes is $45.00.

# INDEXES TO *NSA*

Comprehensive indexes appear in each issue and are cumulated at the end of each volume. The report number indexes will be cumulated on both a volume and two-volume basis. Multivolume cumulations have been issued as indicated above.

All documents abstracted are indexed by subjects and personal authors. Report literature is indexed also by corporate author and report number. Each of these indexes in every issue is preceded by an introduction explaining in detail the organization of the index and the principles by which it is compiled. The reader is referred to these explanations for information not found in the brief summaries below.

## Personal Authors

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

```
HOLLOWAY, J.A., Survey of image
    processing methods for
    radiography, 31:16451
HOLLWEG, J.V., Hydromagnetic waves in
    interplanetary space, 31:17953
HOLMBERG, E.B., Distribution of
    clusters of galaxies as related to
    galactic absorption, 31:16040
HOLMES, J.J., See BATES, J.F., 31:17444
```

## Subjects

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

Examples:

```
NUCLEAR POWER PLANTS/REACTOR LICENSING
  Experience acquired in the design and construction of
    operating plants (German Federal Republic), 31:19104
NUCLEAR POWER PLANTS/REACTOR SAFETY
  Conception of radiation safety in atomic electric power
    plants, 31:15032 (CONF-701074-P1)
NUCLEAR POWER PLANTS/SITE SELECTION
  Safety-related site parameters for nuclear power plants,
    31:19052 (WASH-1361)
  Status and development of nuclear power in the Federal
    Republic of Germany, 31:19105
NUCLEAR PROPERTIES/RESEARCH PROGRAMS
  Accelerator physics group progress report, July--December
    1973 (Research summaries), 31:18544 (INS-R-139)
```

## Corporates

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

17606 (ANL/HEP-7440, pp I.1-I.12) ACCELERATED POLARIZED PROTONS AT THE ZGS. Ratner, L. G. (Argonne National Lab., IL). Feb 1974.
From symposium on high energy physics with polarized beams; Argonne, Illinois, USA (8 Feb 1974).
In symposium on high-energy physics with polarized beams.

is indexed as:

```
ARGONNE NATIONAL LAB., ILL. (USA)
  Accelerated polarized protons at the ZGS, 31:17606
    (ANL/HEP-7440)
  Acceleration of polarized protons in synchrotrons,
    31:17692 (ANL/HEP-7440)
  Analysis of population, birth, and death statistics in
    the counties surrounding the Big Rock Point Nuclear
    Power Station, Charlevoix County, Michigan, 31:16552
    (ANL-8149)
  Argonne polarized target facilities, 31:17762 (ANL/HEP-
    7440)
  Calculation of transient fission-gas release from oxide
    fuels, 31:19031 (ANL-8143)
```

## Report Numbers

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

```
WASH-
  1164              31:19025  Dep. NTIS, $16.00
  1359              31:16524  Dep. NTIS, $10.60
  1361              31:19052  Dep. NTIS, $3.75

WCAP-           (Misc.)
  7986              31:19053  Dep. NTIS, $5.50

XDC-
  60-3-60           31:18403  Dep. NTIS, $7.25

XN-             (Non-ERDA)
  74-21(Rev.1)      31:19084
  409(Suppl.4)      31:16750  Exxon, Richland, WA
  (Rev.1)

Y-
  1966              31:19188  Dep. NTIS, $4.00
```

# AVAILABILITY OF PUBLICATIONS ABSTRACTED

Public availability of all U. S. Energy Research and Development Administration reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

Dissertations from *Dissertation Abstracts International, Part B* that are included in *Nuclear Science Abstracts* are available from Xerox University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106.

Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

# TABLE OF CONTENTS

**Volume 32, Number 12, December 31, 1975**


| Category | Page |
|---|---|
| **CHEMISTRY** | **2731** |
| Analytical and Separations Chemistry | 2731 |
| *Activation and Nuclear Reaction Procedures* | 2731 |
| *Chemical and Spectral Procedures* | 2734 |
| *Radiometric and Radiochemical Procedures* | 2736 |
| *Separation Procedures* | 2738 |
| Inorganic, Organic, and Physical Chemistry | 2739 |
| *Chemical and Physicochemical Properties* | 2739 |
| *Isotope Effects* | 2740 |
| *Isotope Exchange and Isotope Separation* | 2742 |
| Radiation Chemistry | 2742 |
| Radiochemistry and Nuclear Chemistry | 2746 |
| *Hot-Atom Chemistry* | 2746 |
| *Properties of Radioactive Materials* | 2746 |
| *Radioactive Waste Treatment* | 2750 |
| *Radioisotope Production* | 2751 |
| *Reactor Fuel Reprocessing* | 2752 |
| **CONTROLLED THERMONUCLEAR RESEARCH** | **2753** |
| Plasma Confinement and Heating | 2753 |
| Plasma Diagnostics | 2754 |
| Plasma Kinetics (General) | 2756 |
| Plasma Kinetics (Experimental) | 2756 |
| Plasma Kinetics (Theoretical) | 2757 |
| Plasma Production | 2758 |
| Plasma Stability | 2759 |
| Thermonuclear Engineering and Equipment | 2761 |
| Wave Phenomena | 2764 |
| **ENGINEERING** | **2767** |
| Energy Conversion | 2767 |
| Facilities and Equipment | 2767 |
| *Lasers* | 2767 |
| *Cryogenic and Superconducting Equipment and Devices* | 2770 |
| Heat Transfer and Fluid Flow | 2771 |
| Materials Testing | 2772 |
| Nuclear Explosions | 2772 |
| Protective Structures and Equipment | 2773 |
| Safety Engineering | 2773 |
| Vacuum Engineering | 2773 |
| **ENVIRONMENTAL AND EARTH SCIENCES** | **2774** |
| Minerals and Ores | 2774 |
| Radioactivity Monitoring and Transport | 2774 |
| *Atmosphere* | 2775 |
| *Soil* | 2776 |
| *Water* | 2776 |
| *Ecosystems and Food Cycles* | 2776 |
| Radiometric Techniques | 2777 |
| Site Surveys | 2778 |
| Thermal Effluents | 2778 |
| Chemical Effluents | 2780 |
| **INSTRUMENTATION** | **2781** |
| Radiation Detection Instruments | 2781 |
| *General Detectors and Monitors* | 2781 |
| *Radiation Dosimeters* | 2785 |
| *Nuclear Spectroscopic Instrumentation* | 2787 |
| *High Energy Physics Instrumentation* | 2789 |
| Radiometric Instruments | 2790 |
| Radiation Effects on Instrument Components, Instruments, or Electronic Systems | 2791 |
| Miscellaneous Instruments | 2791 |
| **ISOTOPE AND RADIATION SOURCE TECHNOLOGY** | **2793** |
| Isotope Separation (Industrial) | 2793 |
| Isotopic Power Sources | 2793 |
| Radiation Sources | 2794 |
| *Design and Fabrication* | 2794 |
| *Industrial Uses* | 2794 |
| **LIFE SCIENCES** | **2801** |
| Radiation Effects on Biochemicals | 2801 |
| Radiation Effects on Cells | 2803 |
| Radiation Effects on Microorganisms | 2804 |
| Radiation Effects on Plants | 2807 |
| Radiation Effects on Animals | 2809 |
| *Man* | 2809 |
| *Vertebrates* | 2813 |
| *Invertebrates* | 2815 |
| Radionuclide Effects (Internal Source) | 2816 |
| *Man* | 2816 |
| *Animals* | 2816 |
| Nuclide Kinetics and Toxicology | 2816 |
| *Man* | 2816 |
| *Animals* | 2816 |
| *Plants* | 2818 |
| *Microorganisms* | 2818 |
| New Tracer Techniques | 2818 |
| **MATERIALS** | **2823** |
| Ceramics and Cermets | 2823 |
| Metals and Alloys | 2835 |
| *Corrosion and Erosion* | 2836 |
| *Preparation and Fabrication* | 2838 |
| *Properties, Structure, and Phase Studies* | 2840 |
| *Radiation Effects* | 2853 |
| Other Materials | 2855 |
| **NUCLEAR MATERIALS AND WASTE MANAGEMENT** | **2859** |
| Accountability and Safeguards | 2859 |
| Disposal and Storage | 2860 |
| Handling Equipment and Procedures | 2862 |
| Transportation | 2862 |

# TABLE OF CONTENTS (continued)


| Category | Page |
|---|---|
| **PARTICLE ACCELERATORS** | 2864 |
| Design, Development, and Operation | 2864 |
| Auxiliaries and Components | 2869 |
| Ion Sources and Injection and Extraction Systems | 2876 |
| Ion Optics and Field Calculations | 2879 |
| Storage Rings | 2882 |
| Experimental Facilities | 2886 |
| **PHYSICS (ASTROPHYSICS AND COSMOLOGY)** | 2889 |
| Cosmic Radiation | 2889 |
| Stars | 2891 |
| Quasi-Stellar, Radio, and X-Ray Sources | 2897 |
| Solar Phenomena | 2899 |
| Galaxies | 2903 |
| Cosmology | 2905 |
| Planetary Phenomena | 2907 |
| **PHYSICS (ATMOSPHERIC)** | 2911 |
| Auroral and Ionospheric Phenomena | 2911 |
| Effects of Nuclear Detonations | 2915 |
| Magnetospheric Phenomena | 2915 |
| **PHYSICS (ATOMIC AND MOLECULAR)** | 2921 |
| Beams and Their Reactions | 2921 |
| Atomic and Molecular Properties | 2922 |
| Positronium, Muonium, and Muonic and Mesic Atoms and Molecules | 2922 |
| Collision Phenomena | 2923 |
| Atomic Theory | 2925 |
| **PHYSICS (ELECTROFLUID AND MAGNETOFLUID)** | 2926 |
| **PHYSICS (HIGH-ENERGY)** | 2927 |
| Particle Interactions and Properties (Experimental) | 2927 |
| *Electromagnetic* | 2927 |
| *Weak* | 2927 |
| *Strong (Baryon-induced)* | 2928 |
| *Strong (Meson-induced)* | 2929 |
| Particle Interactions and Properties (Theoretical) | 2931 |
| *General* | 2931 |
| *Electromagnetic* | 2935 |
| *Weak* | 2938 |
| *Strong (General)* | 2939 |
| *Strong (Baryon No. = 0)* | 2939 |
| *Strong (Baryon No. = 1)* | 2941 |
| *Strong (Baryon No. ≥ 2)* | 2942 |
| Particle Invariance Principles and Symmetries | 2944 |
| *General* | 2944 |
| *Applications (Electromagnetic and Weak)* | 2944 |
| Scattering Theory | 2944 |
| **PHYSICS (LOW-TEMPERATURE)** | 2948 |
| Superconductivity | 2948 |
| **PHYSICS (NUCLEAR)** | 2951 |
| Neutron Interactions with Matter | 2951 |
| Nuclear Properties and Reactions, A < 5 | 2952 |
| **PHYSICS (NUCLEAR) (Cont'd.)** | |
| Nuclear Properties and Reactions, 6 < A < 19 | 2955 |
| Nuclear Properties and Reactions, 20 < A < 38 | 2959 |
| Nuclear Properties and Reactions, 39 < A < 58 | 2962 |
| Nuclear Properties and Reactions, 59 < A < 89 | 2964 |
| Nuclear Properties and Reactions, 90 < A < 149 | 2966 |
| Nuclear Properties and Reactions, 150 < A < 189 | 2970 |
| Nuclear Properties and Reactions, 190 < A < 219 | 2973 |
| Nuclear Properties and Reactions, A ≥ 220 | 2975 |
| Nuclear Theory | 2977 |
| **PHYSICS (RADIATION AND SHIELDING)** | 2985 |
| Radiation Physics | 2985 |
| Radiation Protection Standards | 2985 |
| Radiation Source Calibration and Standardization | 2985 |
| Shielding Calculations and Experiments | 2986 |
| **PHYSICS (THEORETICAL)** | 2987 |
| General | 2987 |
| Quantum Field Theories | 2988 |
| Gravitation and General Relativity | 2994 |
| **REACTOR TECHNOLOGY AND REGULATION** | 2997 |
| Power Reactors, Non-Breeding, BWR-Type | 2998 |
| Power Reactors, Non-Breeding, PWR-Type | 2999 |
| Power Reactors, Non-Breeding, Graphite Moderated | 3000 |
| Power Reactors, Non-Breeding, Otherwise Moderated | 3004 |
| Power Reactors, Breeding | 3005 |
| Research, Test, and Experimental Reactors | 3009 |
| Production and Materials Testing and Processing Reactors | 3010 |
| Propulsion and Package Reactors | 3010 |
| Reactor Safety and Environmental Aspects | 3015 |
| Reactor Theory and Calculation | 3024 |
| Reactor Components and Accessories | 3025 |
| Reactor Fuels | 3028 |
| Reactor Control Systems | 3028 |
| Nuclear Power Plant Economics | 3029 |
| Reactor Fuel Cycle Economics | 3030 |
| Reactor Licensing and Regulation | 3031 |
| **GENERAL AND MISCELLANEOUS** | 3033 |
| Information Handling | 3033 |
| Law | 3033 |
| Management | 3033 |
| Mathematics and Computers | 3033 |
| **CORPORATE INDEX** | INDEX-1 |
| **PERSONAL AUTHOR INDEX** | INDEX-14 |
| **SUBJECT INDEX** | INDEX-68 |
| **REPORT NUMBER INDEX** | INDEX-201 |

## STAFF OF NUCLEAR SCIENCE ABSTRACTS

**Editor and Production Manager**
David E. Bost

**Assistant Editor**
Lee M. Thompson

**Associate Editors**
M. Catherine Grissom
Robert C. Kelly
Sidney F. Lanier
Henry D. Raleigh
Charles E. Stuber

**Report Evaluators**
John H. Mitchell
Mary H. Newman

**Descriptive Cataloging Specialist**
J. Paul Meredith

**Subject Heading Specialist**
Dora H. Moneyhun

**Corporate Author Specialist**
Clara L. Fox

**Report Number Specialist**
Helen W. White

**Information Specialists**
P. Martin Alexander
E. Ray Bedford
Jane G. Buchanan
D. Lamar Cason
David C. Cunningham
Theodore F. Davis
James R. Dulaney
Stanley D. Frey
Darrell O. Galde
Martha W. Gerrard
Barbara J. Glenn
Everett J. Hoffman
Carolyn D. Houston
Lynda H. Kern
W. Hugh Kinser
Lisbeth C. Lieberman
William D. Matheny
Lorne T. Newman
Jean F. Peckham
Mona H. Raridon
Julia S. Redford
Stanley J. Rimshaw
Jessie W. Rushing
Robert W. Rutkowski
Francis L. Sachs
Lila B. Smith
Polly C. Summers
George H. Thoeming
Helen L. Ward
Lawrence T. Whitehead
Milton O. Whitson
Martha C. Wilson

**Publishing Coordinator**
Charles R. Bruce

**Computer Processing Coordinator**
Noboru Kawakami

**Communication concerning the editorial policy and content of *Nuclear Science Abstracts* should be addressed to the Editor, *Nuclear Science Abstracts*, USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.**

*The Administrator of the Energy Research and Development Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1978.*

Volume 32, Number 12 December 31, 1975

# NUCLEAR SCIENCE ABSTRACTS

# CHEMISTRY

## Analytical and Separations Chemistry

*Refer also to abstract 27929.*

**27458** (CONF-740308-, pp 363-384) DESTRUCTIVE ANALYSIS OF NUCLEAR MATERIALS FOR SAFEGUARDS. von Baeckmann, A. (Kernforschung mbH, Karlsruhe, Ger.). 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

A review is presented of destructive chemical analytical methods for U, Pu, and their isotopic compositions in nuclear fuels. Tables summarize the most frequently used methods and their accuracy and costs, and also the automated methods. Experience gathered in interlaboratory comparison tests is described. (DLC)

**27459** FURTHER DEVELOPMENTS IN THE USE OF X-RAY SPECTROMETRY IN ACTIVATION ANALYSIS. Amiel, S. (Soreq Nuclear Research Center, Yavne, Israel). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 12-13(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

### *Activation and Nuclear Reaction Procedures*

*Refer also to abstracts 28049, 28086–28088, 28715, and 28985.*

**27460** (INIS-mf-1485) INSTRUMENTAL NEUTRON-ACTIVATION ANALYSIS OF PLANTS AFTER ELIMINATION OF $^{24}Na$ AND $^{42}K$. Marinov, V.; Apostolov, D.; Lazarova, M. (Bylgarska Akademiya na Naukite, Sofia; Sofia Univ. (Bulgaria)). Apr 1974. 8p. (In Bulgarian). (CONF-7404114-2). INIS.

From 2nd national conference of the young physicists; Sofia, Bulgaria (10 Apr 1974).

The possibility for instrumental multielement neutron activation analysis of plants after the elimination of $^{24}Na$ and $^{42}K$ with the help of hydratized $Sb_2O_5$ and the ion exchange resin Chelex 100 is studied. The experimental facilities of the IRT-2000-Sofia reactor are used. $^{24}Na$ is eliminated from the solution of activated Bowen cabbage dust by the batch procedure with hydratized $Sb_2O_5$. The effect for $^{42}K$ depends on the acidity of the acid used. Better results are obtained for both elements when Chelex 100 is used instead of $Sb_2O_5$. The authors show the possibility for simultaneous determination of Cu, Zn, Mn, and As and of Br, La, Cr, Eu, Au, Sb, Cs, Zr, Sc, Kb, Fe, Zn, and Co. The methods studied are especially appropriate for analysis of Cu, Au, As, and Zr in plants. (INIS)

**27461** (INIS-mf-1511) NEUTRON ACTIVATION ANALYSIS IN ENVIRONMENTAL WORK. Cilindro, L. G. (Philippine Atomic Energy Commission, Manila). 1974. 9p. (CONF-740375-1). INIS.

From annual convention of the Chemical Society; Manila, Philippines (28 Mar 1974).

Neutron activation analysis (NAA), a very highly sensitive and specific method of elemental analysis, is very useful in environment pollution studies particularly in the analysis of trace amounts of toxic chemical elements in foodstuffs, drinking water, samples of biological tissue, etc. Some activities on NAA evnironmental pollution monitoring works done by the Philippine Atomic Energy Commission are: (a) analysis of arsenic and antimony in water. Two milliliters of the sample and a standard solution are irradiated simultaneously in the reactor for 30 minutes. The samples are then "cooled" and the gamma radioactivities in the sample and the standard are measured in a gamma analyzer equipped with a Ge(Li) crystal scintillation detector. (b) Analysis of bromine in local cereal supplies, and (c) mercury monitoring in fish and other foodstuffs. At the PAEC, a reliable method for trace mercury analysis was developed, this is the so called destructive method of NAA. The procedure, as well as its advantages and disadvantages, is described. The "potentials of NAA as a tool in chemistry studies have not yet been widely exploited". (INIS)

**27462** (NIM-1638) DETERMINATION OF TRACE ELEMENTS IN NATURAL DIAMONDS BY INSTRUMENTAL NEUTRON-ACTIVATION ANALYSIS. Bibby, D. M.; Erasmus, C. S.; Fesq, H. W.; Kable, E. J. D. (National Inst. for Metallurgy, Johannesburg (South Africa)). 1 May 1975. 36p. Dep. NTIS (US Sales Only) $5.00.

A total of more than 1500 individual diamonds, divided into 96 samples, were analysed by neutron activation. These were obtained from three South African mines: Premier, Finsch, and Jagersfontein. The presence of 44 elements in diamonds was established from 61 isotopes, and quantitative results were obtained for 34 elements. (auth)

**27463** INTERNATIONAL NUCLEAR AND ATOMIC ACTIVATION ANALYSIS CONFERENCE AND NINETEENTH ANNUAL MEETING ON ANALYTICAL CHEMISTRY IN NUCLEAR TECHNOLOGY, GATLINBURG, TENNESSEE, OCTOBER 14–16, 1975. Farmakes, R. (ed.). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 1-41(1975).

Summaries of 47 papers are included under the following section titles: neutron activation analysis in biology; charged-particle and photon activation analysis; atomic and nuclear excitation methods; neutron activation analysis in environmental science; special developments and applications of nuclear activation analysis; and x-ray fluorescence techniques. Corporate and author indexes are included. (JGB)

*For listing of individual papers see: 27459, 27464–27493, 27509, 27510, 27537–27543, 28049, 28087, 28088, and 28985.*

**27464** INVESTIGATION OF THE INTERACTION BETWEEN SURGICAL IMPLANTS AND TISSUE BY ACTIVATION ANALYSIS. Lux, F.; Zeisler, R.; Schuster, J. (Technische Univ., Munich). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 1-2(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27465** TRACE CHROMIUM DETERMINATIONS BY NEUTRON ACTIVATION AND OTHER METHODS. Vogt, J. R.; Abu-Samra, A.; Lichte, F.; Ryan, T. R.; Morris, J.; Vogt, C. H.; Koirtyohann, S. R.; Pierce, J. O. (Univ. of Missouri, Columbia). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 2(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27466** APPLICATION OF NEUTRON ACTIVATION ANALYSIS IN THE INVESTIGATION OF TRACE ELEMENT METABOLISM. Behne, D. (Hahn-Meitner Institut fuer Kernforschung, Berlin). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 2-3(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27467** MULTIELEMENT TRACE ANALYSIS BY ATOMIC ABSORPTION SPECTROMETRY AND NEUTRON ACTIVATION ANALYSIS IN BIOLOGICAL MATRICES. Gallorini, M.; Di Casa, M.; Stella, R.; Genova, N.; Orvini, E.; Brandone, A. (Univ., Pavia, Italy). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 3(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27468** OPTIMUM PROCEDURE FOR DETERMINING TRACE ALUMINUM IN URINE BY NEUTRON ACTIVATION ANALYSIS. Blotcky, A. J.; Hobson, D.; Leffler, J.; Rack, E. P.; Recker, R. (Veterans Administration Hospital, Omaha). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 3-4(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27469** SPONTANEOUS DEPOSITION RADIOCHEMICAL SEPARATION FOR PLATINUM DETERMINATION IN BIOLOGICAL MATERIALS. Becker, D. A.; LaFleur, P. D.; LeRoy, A. (National Bureau of Standards, Washington, DC). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 5(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27470** CHARGED-PARTICLE ACTIVATION ANALYSIS. Nozaki, T. (Inst. of Physical and Chemical Research, Wako, Japan). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 6(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27471** GAMMA ACTIVATION OF ENVIRONMENTAL AND BIOLOGICAL MATERIALS. Hislop, J. S.; Williams, D. R. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 6-7(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27472** RECENT ADVANCES IN CHARGED-PARTICLE ACTIVATION ANALYSIS. Schweikert, E. A.; McGinley, J. R.; Stock, J. J. (Texas A and M Univ., College Station). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 7-8(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27473** YIELDS OF PHOTONUCLEAR REACTIONS FOR MULTIELEMENT PHOTON ACTIVATION ANALYSIS. Kato, T. (Tohoku Univ., Sendai). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 8-9(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27474** SURFACE EXPLORATION BY NATURAL AND PROMPT ACTIVATION ANALYSIS EXEMPLIFIED BY APOLLO REMOTE ORBITAL SENSING. Bielefeld, M. J. (Computer Sciences Corp., Silver Spring, MD). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 9(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27475** DETERMINATION OF NITROGEN IN STEELS BY DEUTERON BOMBARDMENT. Olivier, C. (Univ. of Stellenbosch, South Africa); Peisach, M. (Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 9-10(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27476** ALPHA-PARTICLE AND LITHIUM-ION BACKSCATTERING: COMPLEMENTARY METHODS FOR SURFACE ANALYSIS. Tousset, J.; Thomas, J. P.; Cachard, A. (Universite Claude Bernard Lyon, Villeurbanne, France). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 11(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27477** DETERMINATION OF LOW-DOSE BORON-IMPLANTED CONCENTRATION PROFILES IN SILICON BY THE (n,$\alpha$) REACTION. Henkelmann, R.; Mueller, K.; Born, H. J. (Technische Univ., Munich). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 14 (1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27478** DETERMINATION OF FLUORINE BY SPECTROMETRY OF PROMPT GAMMA RAYS. Giles, I. S.; Peisach, M. (Southern Universities Nuclear Inst., South Africa). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 15(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27479** NEUTRON-CAPTURE GAMMA-RAY ACTIVATION ANALYSIS. El-Kady, A. A. (Atomic Energy Establishment, Cairo); Duffey, D.; Wiggins, P. F. Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 15-16(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27480** TRACE-ELEMENT PATHWAYS FROM ENVIRONMENT TO MAN. Clemente, G. F. (CNEN, Rome). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 17(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27481** NEUTRON ACTIVATION ANALYSIS OF AIRBORNE PARTICULATE MATTER IN SPANISH CITIES. Travesi, A. (Junta de Energia Nuclear, Madrid). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 17-19(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27482** OCCURRENCE OF LEAD ALONG A FREEWAY IN A RURAL AREA. Desaedeleer, G.; Ronneau, C. (Louvain Univ., Belg.). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 19(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27483** NEUTRON ACTIVATION ANALYSIS ON WATER SAMPLES FROM THE ENVIRONMENT. van Dalen, A.; Das, H. A.; Luten, J.; van der Sloot, H. A. (Reactor-Centrum Nederland, Petten). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 20(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27484** ELEMENTAL ANALYSIS OF WATER AND AIR SOLIDS BY NEUTRON ACTIVATION ANALYSIS. Bate, L. C.; Lindberg, S. E.; Andren, A. W. (Oak Ridge-Holifield National Lab., TN). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 20-21(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27485** NEUTRON ACTIVATION ANALYSIS FOR TRACE ELEMENTS IN COALS, ASHES, AND RELATED MATERIALS FROM COAL-TREATMENT FACILITIES. Kucera, E. T.; Heinrich, R. R. (Argonne National Lab., IL). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 21-22(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27486** ACTIVATION ANALYSIS AND DENDROCHRONOLOGY FOR ESTIMATING POLLUTION HISTORIES. Pillay, K. K. S. (Penn. State Univ., University Park). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 22-23(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27487** MERCURY AND CADMIUM CONCENTRATIONS IN MILK IN PUERTO RICO. Chellappan, S.; Pedersen, K. B.; Plaza, H. (Univ. of Puerto Rico, Mayaguez). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 23-24(1975).
From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27488** CHARACTERIZATION OF HIGH-PURITY MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Revel, G. (Centre d'Etudes de Chimie Metallurgique, Vitry, France). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 25(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27489** PRECISION HIGH-SPEED NEUTRON ACTIVATION ANALYSIS VIA VERY SHORT-LIVED ACTIVITIES. Guinn, V. P.: Miller, D. A. (Univ. of California, Irvine). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 25-26(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27490** MEASUREMENT OF ARGON LEAKS THROUGH SEALS OF LIQUID-SODIUM PUMPS BY NEUTRON ACTIVATION ANALYSIS. van Dalen, A.; van der Bergh, J. W. H. (Reactor Centrum Nederland, Petten, Netherlands). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 27(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27491** INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF MARBLE: A PROPOSED METHOD FOR RECONSTRUCTION OF BROKEN ARTIFACTS. Miller, G. E.; Sangermano, L.; Bunker, D. L. (Univ. of California, Irvine). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 27(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27492** GEOMETRY EFFECTS IN SMALL SAMPLES ANALYZED BY NAA. Miller, G. E.; Sangermano, L. (Univ. of California, Irvine). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 27-28(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27493** OXYGEN AND NITROGEN IN COAL BY INAA: IMPLICATIONS FOR CONVERSION. James, W. D.; Chyi, L. L.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 30(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27494** MATHEMATICAL–STATISTICAL EVALUATION OF THE RESULTS OF ACTIVATION ANALYSIS FOR THE DETERMINATION OF CONCENTRATION PROFILES IN SILICON. Heinze, W.; Kahl, M. (Technische Hochschule, Ilmenau, Ger.). Isotopenpraxis; 11: No. 6, 210-215(Jun 1975). (In German).

It is explained how by means of mathematical-statistical evaluation of the results of neutron activation analyses one can come to an objective judgement on the thus determined concentration profiles of doping elements in silicon. (auth)

**27495** USE OF PHOSPHOANTIMONIC ACID FOR ARSENIC DETERMINATION BY ACTIVATION ANALYSIS. Simkova, M. (Nuclear Research Inst., Rez, Czech.). Isotopenpraxis; 11: No. 6, 207-210(Jun 1975).

A method was elaborated to determine arsenic amount in skin samples by neutron activation analysis and high-resolution gamma spectrometry including sample preparation after mineralization by sorption on silica gel saturated with phosphoantimonic acid. The samples were irradiated in the VVR-S reactor core in a flux of $10^{13}$ neutrons$\cdot cm^{-2} \cdot s^{-1}$, mineralized with a mixture of nitric and sulfuric acids, the gamma spectrum was measured after passing through an ion exchanger containing 0.5 mol $P_2O_5$ to 1 mol $Sb_2O_5$ (SP-2) by a gamma-spectroscopy system PLURIMAT 20 with a Ge(Li) detector, and the $^{76}As$ photopeak of $E_\gamma$ = 0.559 MeV was measured. The values of the results obtained varied in the range of $(4-5) \times 10^{-1}$ ppm arsenic. The sensitivity of the proposed determination method is $1 \times 10^{-3}$ μg arsenic. (auth)

**27496** DIRECT ADSORPTION OF SOLVENT–EXTRACTED GOLD ON A CHELATING ION EXCHANGE RESIN. Sundberg, L. L. (Univ. of California, Los Angeles). Anal. Chem.; 47: No. 12, 2037-2040(Oct 1975).

Stony meteorites and returned lunar materials are analyzed for Au, Cd, Ge, Ga, In, Ir, Ni, and Zn by radiochemical neutron activation analysis. One of the early steps in the radiochemical procedures is the separation of Au from Zn and Cd by the extraction of gold into ethyl acetate from an HCl solution and then back-extraction of the gold with 25 percent $NH_4OH$ to remove coextracted radionuclides. These procedures can be simplified and shortened by direct adsorption of solvent-extracted Au on a chelating ion exchange resin that excludes the undesired coextracted radionuclides of other elements. (LK)

**27497** SIMULTANEOUS OBSERVATION OF RUTHERFORD SCATTERING AND $(\alpha,x)$ REACTIONS IN $AlF_3$ AND $MgF_2$ LAYERS AND CORRELATIONS WITH THEIR ELECTRICAL PROPERTIES. Saboya, B. (Bordeaux Univ., Gradignan, France); Chemin, J. F.; Roturier, J.; Barriere, A.; Danto, Y.; Salardenne, J. J. Phys., D (London); 8: No. 9, 1008-1020(21 Jun 1975).

An analysis, by nuclear methods, of $AlF_3$ and $MgF_2$ thin films was made using 2.5-MeV $He^+$; backscattered $\alpha$ particles and K x rays emitted in $(\alpha,x)$ reactions are observed. The impurity concentrations are strongly dependent on the conditions of preparation and can reach high values. Electrical properties of such thin films appear to be nearly independent of the impurity concentrations and are discussed in the frame-work of the Mott–Davis model. (auth)

**27498** DETERMINATION OF TRACE AMOUNT OF MERCURY IN HUMAN HAIR BY NEUTRON ACTIVATION ANALYSIS. Yeh, S. J.; Chen, P. Y.; Hsu, S. T. (National Tsing Hua Univ., Hsinchu, Taiwan). J. Chin. Chem. Soc. (Taiwan); 22: No. 1, 17-24(Mar 1975).

Trace amount of mercury in human hair has been determined by destructive neutron activation analysis. It was found that the content of mercury in the hair of normal people in Taiwan area on the order of 6 ppm. It is of interest to point out that very little fluctuation is observed in the content of mercury in human hair regardless of sex and age of the normal people under investigation. On the other hand for those people who are working in the caustic soda manufacturing plant in which mercury is used as cathode in the electrolysis process of saline water, the mercury contents in their hair are definitely much higher (ca. 30 times) than the average values of normal people. (auth)

**27499** MEASUREMENT OF LIVER-CADMIUM CONCENTRATIONS IN PATIENTS AND INDUSTRIAL WORKERS BY NEUTRON-ACTIVATION ANALYSIS. Harvey, T. C.; McLellan, J. S.; Thomas, B. J.; Fremlin, J. H. (Univ. of Birmingham, Eng.). Lancet; 1: No. 7919, 1269-1272(7 Jun 1975).

A new, rapid, non-invasive technique for measuring tissue-cadmium concentrations in patients and industrial workers was designed and developed with a view to studying the cadmium content of the liver. The method utilizes the principle of neutron-activation analysis whereby the specific changes produced by the interaction of nuclei and neutrons are analyzed. Liver-cadmium content has been studied in cadavers and in four men with known or suspected cadmium poison. The patients all showed very high liver-cadmium levels of between 35 and 200 ppm compared with under 1.0 ppm in non-exposed subjects. The dose of radiation used in clinical studies was 0.4 to 1.0 rem and the detection limit of cadmium was 1.0 ppm. (auth)

**27500** METHOD OF MEASURING ETCHING VELOCITIES IN PLASTIC NUCLEAR-TRACK DETECTORS. Tanti-Wipawin, W. (Birmingham Univ. (UK). Dept. of Physics). Nucl. Instrum. Methods; 126: No. 4, 597-598(1 Jul 1975).

A simple method of measuring the etching velocities is reported and the etching parameters studied in LR 115 type 2, a double-layer cellulose–nitrate nuclear-track detector. (auth)

**27501** NOVEL TECHNIQUES IN CHARGED PARTICLE ACTIVATION ANALYSIS. McGinley, J. R. College Station, TX; Texas A and M University (1974). 144p. University Microfilms Order No. 75-15,042.

Thesis (Ph. D).

Two novel techniques were studied with the objective of expanding the scope of charged particle activation analysis for low, medium, and high Z elements: quasi-prompt counting of high energy beta-particles and detection of x-rays emitted during nuclear decay. A rapid, sensitive, nondestructive technique for the analysis of Li, B, C, S, and Si was developed utilizing proton and deuteron reaction products with 11 msec less than or equal to $t_{1/2}$ less than or equal to 850 ms. This approach, termed quasi-prompt activation, combines advantages of prompt as well as delayed counting techniques. The experimental set-up developed for quasi-prompt activation analysis included a sensitive and selective high energy beta-particle detector system and a method of obtaining short bursts (t greater than or equal to 200 mu sec) of high energy charged particles on target. The application of this technique is illustrated with data on the nondestructive trace analysis of Li, B, C, and S in a variety of solid and liquid samples. The experimental detection limits, dependent on the matrix/element combination being analyzed, vary from 0.25 ppM (B in Si) to 50 ppM (S in gasoline). The possibility of nondispersive x-ray counting following charged particle activation was studied as a means of multielement, nondestructive trace analysis of medium and high Z elements (Z greater than 26). An evaluation was made of different types of nondispersive x-ray detectors. Thick target yields and interference-free detection limits are

presented for the proton and deuteron activation products of 38 elements. The application of this technique is illustrated with data on the simultaneous determination of up to 26 elements in NBS standard glass samples at the 500, 50, and 1 ppM levels using 20 MeV proton activation. (Diss. Abstr. Int., B)

**27502** SUBSTOICHIOMETRIC NEUTRON-ACTIVATION DETERMINATION OF GALLIUM. Mitchell, J. W.; Riley, J. E. (Bell Telephone Labs., Murray Hill, NJ). Talanta; 22: No. 7, 567-570(Jul 1975).

A highly precise method for the determination of traces of gallium by neutron activation is described. Conditions for the extraction of gallium are reported and general requirements for substoichiometric isolation of cations from HCl with neutral donors are discussed. The mean of determinations of gallium at concentrations of 40 ng/ml in a solution prepared by dissolving a standard reference aluminium alloy was 213.9 ± 1.3 NG. The relative standard deviation and the total error of the method (based on the SRM value) were 0.7 and 10.5% respectively. (auth)

**27503** COMPARISON OF SPECTRAL- AND RADIOANALYSIS ON THE BASIS OF DETERMINATIONS OF IMPORTANT FOREIGN ELEMENTS IN TUNGSTEN. Horkay, K.; Bereznai, T.; Hegedus, A. J. Mikrochim. Acta; 2: No. 3, 343-352(1975). (In German).

On the basis of determinations of small quantities of Al, Fe, K and Si, in $WO_3$- or W-powder, a comparison was made with regard to the reliability of the emission-spectral analysis, of the reactor activation analysis and of the generator activation analysis on the basis of approximately 400 parallel measurements. One-sided methodical errors, the possibility of their elimination or lessening were founded or stated. According to the findings, which showed the applicability and reliability of the studied three methods, for the given instance, the employment of emission spectral analysis is most useful and economical. (auth)

## Chemical and Spectral Procedures

*Refer also to abstracts 27570, 27572, 27664, 28100, 28640, and 30218.*

**27504** (AWRE-O-34/75) POLAROGRAPHIC METHODS FOR THE ANALYSIS OF BERYLLIUM METAL AND ITS ALLOYS. Wells, J. M. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). Oct 1975. 50p. Dep. NTIS (US Sales Only) $5.50. UK pounds1.00.

Polarographic methods for the analysis of beryllium metal and its alloys are described. The elements covered by these methods are aluminium, bismuth, cadmium, cobalt, copper, iron, lead, molybdenum, nickel, thallium, tungsten, uranium, vanadium and zinc. (auth)

**27505** (AWRE-O-35/75) ANALYTICAL METHODS FOR LEAD–ZIRCONIUM TITANATE CERAMIC MATERIALS. Wells, J. M. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). Oct 1975. 24p. Dep. NTIS (US Sales Only) $4.25. UK 50 pence.

The methods of analysis described in this report were developed at AWRE, Aldermaston. The ceramics being produced were expected to be mainly of the nominal compositions $Pb(Zr_{0.65}Ti_{0.35})O_3$ and $Pb(Zr_{0.52}Ti_{0.48})O_3$, with small additions of a tri- or pentavalent atom to increase the resistivity of the final product. Niobium was the main element used for this purpose, but some experimental batches using bismuth were also produced. The method for the determination of lead had to be modified in the presence of bismuth and details of this and a method for the determination of bismuth are included. (auth)

**27506** (INIS-mf-1723) ADDITION COMPOUNDS OF LANTHANIDE PERCHLORATES AND YTTRIUM WITH THE TETRAMETHYLPHTHALAMIDE N, N, N', N' OF PHTHALIC ACID. Silva, C. P. G. da. (Sao Paulo Univ. (Brazil). Instituto de Quimica). 1974. 83p. (In Portuguese). INIS.

The reaction between lanthanide perchlorates and yttrium with tetramethylphthalamide (TMPA) was studied, and compounds of the general formula $Ln(ClO_4)_3$. TMPA were isolated. The addition compounds prepared have a fine powder aspect and are faintly colored when compared to the corresponding hydrated lanthanide ions; they are not hygroscopic and generally soluble in polar solvents. The compounds were characterized by analysis of their components, infrared spectra, molar conductances in nitromethane, and nitrobenzene, x-ray powder patterns, and thermal analysis. Infrared spectra showed that the compounds are anhydrous and that the ligand is bonded to the lanthanide ion through the carbonyl oxygen. The perchlorate ion shows tetrahedral symmetry in all compounds. Conductance measurements indicated that the addition compounds are 1:3 electrolytes in nitromethane and nitrobenzene. According to x-ray patterns, the compounds were grouped in three isomorfic groups. The first group contains the compounds from lanthanum to neodymium; the second, compounds from samarium to holmium and yttrium and the third, the compounds of thulium and ytterbium. The compounds of lutetium do not belong to any of the groups mentioned. The thermal gravimetric analysis for some compounds showed decomposition at about 250°C followed by explosion around 405°C. (INIS)

**27507** (ORNL-tr-2969(DR)) ANALYSIS OF LITHIUM "DEUTEROTRITIDE". Lefevre, H.; Reversat, G.; Putaux, J. C. Translated by Martha Gerrard from Bull. Inf. Sci. Tech. (Paris); 178: 51-54(1973). 7p. Dep. NTIS $4.00.

The conditions for analysis of lithium deuteriotritide are studied. The components (H, D, T, Li) and the main impurities (C, N, O) are determined. Only a few hundreds of mg of the compound are necessary for these analysis which must be carried on in gloveboxes. (auth)

**27508** (Y-1991) STUDY OF FACTORS AFFECTING A COMBUSTION METHOD FOR DETERMINING CARBON IN LITHIUM HYDRIDE. Barringer, R. E.; Thornton, R. E. (Oak Ridge Y-12 Plant, Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 26p. Dep. NTIS $4.00.

An investigation has been made of the factors affecting a combustion method for the determination of low levels (300 to 15,000 micrograms/gram) of carbon in highly reactive lithium hydride. Optimization of the procedure with available equipment yielded recoveries of 90 percent, with a limit of error (0,95) of +-39 percent relative for aliquants containing 35 to 55 micrograms of carbon (500 to 800 micrograms of carbon per gram of lithium hydride sample). Sample preparation, thermal decomposition of the hydride, final ignition of the carbon, and carbon-measurement steps were studied, and a detailed procedure was developed. (auth)

**27509** APPLICATION OF X-RAY-INDUCED X-RAY FLUORESCENCE ANALYSIS TO ENVIRONMENTAL CHEMISTRY PROBLEMS. Giauque, R. D. (Univ. of California, Berkeley). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 31-33(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27510** ENERGY-DISPERSIVE X-RAY FLUORESCENCE: A GENERAL-PURPOSE ANALYTICAL TOOL. Cooper, J. A. (ORTEC Inc., Oak Ridge, TN). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 33-34(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27511** QUANTITATIVE DETERMINATION OF THE CONTENT OF THE ISOTOPIC LABEL IN ORGANIC COMPOUNDS. Zyakun, A. M. (Inst. of Biochemistry and Physiology of Microorganisms, Pushchino-on-Oka, USSR). Bull. Acad. Sci. USSR, Div. Chem. Sci.; 23: No. 10, 2144-2146(Oct 1974).

Translated from Izv. Akad. Nauk SSSR, Ser. Khim.; 23: No. 10, 2226-2229(Oct 1974).

In the case of partial replacement of certain atoms of the corresponding element in an organic molecule by their isotopes, it is possible to calculate the number of centers at which replacement occurred and to determine the quantitative ratio of the number of molecules containing isotopically heavy atoms to the number of molecules containing isotopically light atoms, with respect to all the centers. (auth)

**27512** FLAMELESS ATOMIC ABSORPTION SPECTROMETRY EMPLOYING A WIRE LOOP ATOMIZER. Newton, M. P.; Davis, D. G. (Univ. of New Orleans). Anal. Chem.; 47: No. 12, 2003-2009(Oct 1975).

The use of a versatile flameless atomizer for atomic absorption spectrometry, which employs an electrically heated tungsten alloy wire loop, is reported in this study. Several sampling methods were investigated including electrolytic deposition. The relative standard deviation was usually between 1–3.5 percent. The detection limits of 19 elements have been compared for the various sampling methods. (auth)

**27513** SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM BY THE DITHIOOXAMIDE METHOD. Williams, D. A.; Holcomb, I. J.; Boltz, D. F. (Wayne State Univ., Detroit). Anal. Chem.; 47: No. 12, 2025-2027(Oct 1975).

A systematic study of sulfur-containing ligands as chromogenic reagents has resulted in the development of a new spectrophotometric method for determination of molybdenum. Dithiooxamide has been found to give a blue color with molybdenum (VI) that serves as the basis of this method. (LK)

**27514** CHEMISM AND MORPHOLOGY AND POWER PLANT DUSTS. Kautz, K. (VGB Technische Vereinigung der Grosskraftwerksbetreiber eV, Essen); Kirsch, H.; Singh Dev, R. VGB Kraftwerkstech.; 55: No. 3, 180-187(Mar 1975). (In German).

From VGB conference on chemistry in the power plant 1974: VGB feed water conference 1974; Essen, F. R. Germany (29 Oct 1974). 19 figs.; 5 tabs.; 10 refs.

Crude gas dusts, electrostatic precipitator dusts and pure gas dusts from power facilities were analyzed by new methods. In addition to the common Bausch analysis, many trace elements (Ag, Ba, Ca, Cd, Co, Cr, Cu, F, Mg, Mo, Ni, Pb, Ti, V, Zn) were detected by atomic absorption. Some elements like Hg and B required elaborate analytical and methodical preparatory work. Structural analyses of many dust particles were carried out by electron fine range diffraction in a transmission-type electron microscope. In most cases, chemism and crystal structure of a dust grain allow an exact determination of the chemical compound (or its modification) present in the dust grain. (GE)

**27515** Ni, Si, Cu, Mn, Al, AND Mo CONTENTS IN SOME STEEL SAMPLES. U Tin Aung (Arts and Science Univ., Rangoon); U Htin Aung; U Hla Myint; Kumar, K.; Daw Than Tin. Union Burma J. Sci. Technol.; 4: No. 1, 177-185(Apr 1971).

Percent contents of Ni, Si, Cu, Mn, Al and Mo in B.I.S.R.A. steel samples were determined by stepped-sector method of spectrographic analysis. Results obtained from density difference–log concentration and line width concentration working curves are compared. (auth)

**27516** SCANDIUM LUMINESCENCE IN THE COMPOUND WITH 2-PHENYLQUINOLINE-4-CARBOXYLIC ACID AND ITS ANALYTICAL APPLICATIONS. Bel'tyukova, S. V.; Drobyazko, V. N.; Kononenko, L. I.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 30: No. 7, 1321-1324(Jul 1975). (In Russian).

Conditions were found for determining scandium with 2-phenylquinoline-4-carboxylic acid from the luminescence of the suspension of the compound formed. A procedure was worked out of determining scandium in a binary mixture with a rare earth metal. The coefficient of variation is not more than 5%. (auth)

**27517** REACTION BETWEEN TRIS-1-PHENYL-3-METHYL- AND TRIS-1-TOLYL-3-METHYLPYRAZOLONATES OF RARE EARTHS AND SODIUM TETRAPHENYLOBRATE AND ITS USE FOR LUMINESCENCE DETERMINATION OF TERBIUM. Poluektov, N. S.; Tishchenko, M. A.; Gerasimenko, G. I. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 30: No. 7, 1325-1329(Jul 1975). (In Russian).

Conditions were determined for the formation of complexes involving a rare earth metal ion, 1-phenyl-3-methylpyrazolone-5 (1-tolyl-3-methylpyrazolone-5), and sodium tetraphenylborate. The ratio of the components in the compounds studied was determined. The intense luminescence was observed during irradiation of the terbium complex suspensions with ultraviolet light. The effect of various factors was studied on the luminescence intensity. A luminescence procedure was developed for determining terbium microamounts in rare earth metal oxides with a sensitivity $n \cdot 10^{-4}\%$ $Tb_4O_7$, the coefficient of variation being 2.36%. (auth)

**27518** SPECTROGRAPHIC DETERMINATION OF RARE EARTHS IN SOME FLUORIDES. Karpenko, L. I.; Fadeeva, L. A.; Shevchenko, L. D. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 30: No. 7, 1330-1336(Jul 1975). (In Russian).

The effect of Be, Mg, Ca, Sr, and Ba has been examined on spectrographic determination of rare earths in solutions introduced into the excitation source by a combined electrode with a porous cap. Conditions have been found for simultaneous dissolution of fluorides of rare earths and the second group elements alloyed with rare earths. A chemical-spectrographic method has been developed of determining individual rare earths in fluorides of rare earths and the second group elements alloyed with 0.02–0.08% $Me_2O_3$ (Me = Y, Yb, Eu); 0.2–0.6% $Me_2O_3$ (La, Sm, Gd, Tb, Dy, Ho, Er, Tm, Lu); and 1.5% $Me_2O_3$ (Ce, Pr, Nd). One set of standards (in depending on the nature and concentration of the main component) is used in the method; the standards contain only the rare earths to be determined and a reference element. The coefficient of variation is 8–10%. (auth)

**27519** DETERMINATION OF AMERICIUM IN CURIUM BY USING DISCHARGE IN A HOLLOW CATHODE. Zakharov, E. A.; Myasoedov, B. F.; Lebedev, I. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 30: No. 7, 1344-1348(Jul 1975). (In Russian).

The usage of a hot hollow cathode of a simple geometry permits determination americium (to $1 \cdot 10^{-7}$ g) in curium with a coefficient of variation between 17 and 25%. The variation of transportation of americium into the hollow cathode plasma is the main factor which influences the precision. (auth)

**27520** DETERMINATION OF ZIRCONIUM WITH QUERCETINSULFONIC ACID. Ramonaite, S. P.; Kishkite, M. M. (Vilnyus State Univ., USSR). Zh. Anal. Khim.; 30: No. 7, 1361-1364(Jul 1975). (In Russian).

The reaction between zirconium and quercetinsulfonic acid has been studied. The formation of two complexes has been established. The first complex with a molar ratio of the components of 1:2 is formed at pH 0.1–0.3 (its absorption maximum is at 420 nm, the molar absorptivity equals 22500). The second complex with a molar component ratio of 1:1 is formed at pH 1.0–4.1 (the absorption maximum is at 440 nm, the molar absorptivity equals 15,000). The color reaction of zirconium with quercetinsulfonic acid has been used for photometric determination of zirconium in silicates. (auth)

**27521** USE OF DISTILLATION SEPARATION OF ELEMENTS FOR INCREASING THE SENSITIVITY OF SPECTROGRAPHIC ANALYSIS. Staikov, A. I.; Zakhariya, N. F. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 30: No. 7, 1375-1379(Jul 1975). (In Russian).

A sensitive spectrographic method has been developed for determination of 11 elements as impurities in vanadium pentoxide and other vanadium oxides at the impurity levels $10^{-5}\%$ and higher. The samples under test are preliminary converted into vanadium trioxide. The impurities are distilled in the arc plasma in the presence of AgCl; an additional buffer effect is due to vaporization of NaCl from the counterelectrode. (auth)

**27522** SPECTROPHOTOMETRIC STUDY OF A DIFFERENT-LIGAND COMPLEX OF MOLYBDENUM WITH PYROGALLOL RED AND DIMETHYLDIOCTADECYLAMMONIUM. Morgen, E. A.; Rosinskaya, E. S.; Vlasov, N. A. (Irkutsk State Univ., USSR). Zh. Anal. Khim.; 30: No. 7, 1384-1388(Jul 1975). (In Russian).

A different-ligand complex with a component ratio 1:2:2 is formed in the Mo(VI)—pyrogallol red—dimethyldioctadecylammonium chloride system; the molar absorptivity of the complex is $(4.2 \pm 0.04) \cdot 10^4$. A spectrophotometric procedure has been developed of determining molybdenum in natural water. The method sensitivity is 0.03 μg/ml. (auth)

**27523** EXTRACTION CONCENTRATION OF TELLURIUM WITH METHYL ISOBUTYL KETONE IN ANALYSIS OF ORES AND MINERALS. Nazarenko, I. I.; Kislova, I. V.; Rabinovich, B. S. (Inst. of Mineralogy, Geochemistry, and Crystallochemistry of Rare Elements, Moscow). Zh. Anal. Khim.; 30: No. 7, 1389-1394(Jul 1975). (In Russian).

The extraction of tellurium (IV) has been studied with methyl isobutyl ketone from hydrochloric acid solutions of rocks and ores of different composition. Tellurium extraction suppression has been observed for the samples containing large iron amounts. A method has been developed of extraction concentration of tellurium and its separation from large amounts of Fe and Cu as well as from Au, Tl, Se, Sb, Bi, Sn, Co, Ni, and other elements. A procedure has been worked out of extraction-spectrophotometric determination of tellurium in ores with a limit of detection $2 \cdot 10^{-5}\%$ and an error 4–10%. (auth)

**27524** INVERSION VOLTAMMETRY OF TELLURIUM IN A THIN SOLUTION LAYER. Zakharchuk, N. F.; Yudelevich, I. G.; Chernov, S. V. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Zh. Anal. Khim.; 30: No. 7, 1427-1430(Jul 1975). (In Russian).

A cell has been designed for inversion voltametry in a solution microvolume. Conditions have been chosen for determining tellurium by thin-layer inversion voltammetry at a graphite electrode. The possibilities have been shown of coulometric determination of tellurium by the method suggested. (auth)

**27525** DETERMINATION OF TOTAL IODINE IN MILK BY X-RAY FLUORESCENCE SPECTROMETRY AND IODIDE ELECTRODE. Crecelius, E. A. (Battelle-Northwest, Richland, WA). Anal. Chem.; 47: No. 12, 2034-2035(Oct 1975).

Two new techniques are described for the measurement of iodine in milk: direct x-ray fluorescence analysis of a freeze-dried milk sample and the use of an iodide electrode method for analysis of fresh milk. The precision for replicate analyses by either technique showed a standard duration of +-10 percent. The detection limit, defined as twice the noise level, is 0.1 ppM iodine for x-ray fluorescence and 0.05 ppM iodine for the iodide electrode. (LK)

**27526** COMPARATIVE STUDY OF BORIC ACID–SORBITOL COMPLEXES IN $D_2O$, $H_2O$ AND MIXTURES OF $D_2O$ AND $H_2O$: APPLICATION TO THE DETERMINATION OF BORON AT LOW CONCENTRATIONS. Krishna Rao, K. S.; Venkateswarlu, K. S.

(Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 13: No. 6, 741-743(Jul 1975).

Enhanced ionization of boric acid on complexation with sorbitol in $D_2O$, $H_2O$ and mixtures of $D_2O$ and $H_2O$ has been studied by the measurement of conductivity. The differences in the behavior of the complex in $D_2O$ and $H_2O$ were much more pronounced at higher concentrations of boric acid as was shown by a decrease in the ratio $K_{H_2O}/K_{D_2O}$. Based on this study, a sensitive and rapid method is evolved for the determination of boron at low concentrations as encountered in the moderator circuit of RAPS-type pressurized water power reactor. (auth)

**27527** INTERPRETATION OF SECONDARY ION MASS SPECTRA BY MEANS OF FINGERPRINT SPECTRA AND SECONDARY ION IMAGING. Werner, H. W.; Morgan, A. E.; de Grefte, H. A. M. (Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands). Forschungslaboratorium). Appl. Phys.; 7: No. 1, 65-69(May 1975).

A passive layer, of several thousand A thickness, formed on a polycrystalline nickel electrode, was examined using secondary ion mass spectrometry (SIMS) by sputtering with a 5.5 keV, 13 $\mu A \times cm^{-2}$, $^{40}Ar^+$ primary beam. Concentration profiles were derived by monitoring the intensities of atomic and molecular mass peaks as a function of sputtering time (i.e., depth). Nickel was present throughout the layer but not as the element since the relative intensities of the $Ni_n^+$ (n = 1, 2, 3, 4) peaks, constituting part of its fingerprint spectrum, differed from those in the fingerprint spectrum of elemental nickel. These values were eventually reached, signifying piercing of the layer and thus providing a means of estimating its thickness. Imaging of $^{58}Ni^+$ showed the presence of nickel in at least two different modifications in the layer, both with higher $Ni^+$ yields than the bulk nickel. (auth)

**27528** METALLOGRAPHIC PREPARATION IN "HOT CELLS". Pejsa, R.; Hellriegel, W. (Kernforschungszentrum Karlsruhe (F. R. Germany). Abt. Reaktorbetrieb und Technik). Prakt. Metallogr.; 11: No. 12, 705-715(Dec 1974). (In German and English).

From meeting on metallography; Iserlohn, F. R. Germany (12 Sep 1973). 9 figs.; 11 refs.

A unit and its fittings designed for the metallography of highly radioactive materials are described. The apparatus has been in operation for 5 years without any noteworthy breakdowns. The methods of preparation, which depended on the aim of the investigation, are discussed with reference to several examples. They allow both the metallographically quantitative determination of microstructural parameters and the determination of the chemical composition with a microprobe. (auth)

**27529** METHODS FOR THE DETERMINATION OF SELECTED ELEMENTS INCLUDING Mo, W, AND Re IN GEOLOGICAL SAMPLES. Kim, C. H. Kensington, Australia; University of New South Wales (1974). vp. Librarian, Univ. of New South Wales, Kensington, Australia.

Thesis (Ph. D.).

Improved methods for the determination of Mo, W, and Re in soils and geological materials by atomic absorption spectroscopy (AAS) are described. The procedures are based on various solvent extraction procedures involving the thiocyanate complexes of the elements and subsequent aspiration of the organic extract into nitrous oxide–acetylene flame. Of various organic solvents examined, methyl isobutyl ketone (MIBK) was found suitable for obtaining improved sensitivity and is most suitable for aspiration into nitrous oxide–acetylene flame. The limits of detection of Mo, W, and Re in MIBK are 0.018 ppM, 0.74 ppM, and 0.35 ppM respectively. Comprehensive studies of the extraction of Mo thiocyanate complex with MIBK have resulted in an improved method for the determination of traces of Mo in soils and geological materials. The method is applicable in the range 1 to 500 ppM Mo, with 1 g sample, giving relative standard deviations not exceeding about 8% at a level of 1 ppM. The extraction procedure developed using Alamine 336–$CHCl_3$ was developed for the determination of W in soils and geological materials ranging from 1.5 ppM to 600 ppM with a single working curve. The use of tin metal for the reduction of W, also resulted in an improved method for elimination of many interfering elements including Mo, Fe, and Cu. Studies on the extraction of Mo thiocyanate complex with Aliquat 336–$CHCl_3$ led to a suitable procedure for the determination of 0.1 ppM level Mo in soils (with 1 g of sample) and 1 ppB level Mo in water (with 100 ml of water sample). 100 to 10,000 fold amounts of metal and nonmetal ions over the quantity of Mo were found to have no effect on the determination of Mo by this method. (Diss. Abstr. Int., B)

**27530** PLASMATRONS USED FOR SPECTRAL ANALYSIS. Kleinmann, I.; Svoboda, V. (Inst. for Research, Production, and Use of Radioisotopes, Prague). Chem. Listy; 69: No. 8, 833-854(Aug 1975). (In Czech).

A description is given of plasmatrons used in emission spectral analysis. Constructional problems, different methods of the introduction of liquid and powdered samples into the discharge, and the analytical results achieved are discussed. Among the elements determined are Be, Mo, Sc, Y, La, Pr, Nd, Sm, Gd, Ce, Yb, Zr, and Nb. (auth)

**27531** PROCEDURES FOR THE OPERATIONAL CHEMICAL CONTROL OF NITROGEN TETRAOXIDE COOLANT. Kovaleva, E. P.; Lomako, L. T.; Timofeeva, V. Ya.; Trubnikov, V. P. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 40-46(1975). (In Russian).

Procedures of the quantitative determination of NO and $N_2O$ in the nitrogen tetroxide coolant using reaction chromatography and of NO using the dielectric constant with a preliminary oxidation of nitrogen oxide is given. (auth)

**27532** SELECTIVE METHOD FOR THE DETERMINATION OF MOLYBDENUM USING TOLUENE-3, 4-DITHIOL. de Silva, M.E.M.S. (Government Analys's Lab., Colombo, Ceylon). Analyst; 100: No. 1192, 517-521(Jul 1975).

A method is described for the colorimetric determination of molybdenum. The procedure involves the extraction of molybdenum (VI) from solution in hydrochloric acid with tri-n-butyl phosphate. The tri-n-butyl phosphate extract is then complexed with toluene-3, 4-dithiol in glacial acetic acid–tri-n-butyl phosphate–orthophosphoric acid medium. This procedure enhances the selectivity, sensitivity, and reproducibility of the molybdenum–dithiol reaction. (auth)

**27533** 2'-HYDROXYCHALCONE AS AN ANALYTICAL REAGENT FOR BERYLLIUM. Naidu, R. R. (Sri Venkateswara Univ., Tirupati, India). Talanta; 22: No. 7, 614-616(1 Aug 1975).

Detailed investigations were made of the gravimetric determination of beryllium with 2'-hydroxychalcone and its separation from aluminium, iron, and other elements associated with it in its minerals, and the procedure developed was applied to the gravimetric determination of beryllium in beryl. (auth)

**27534** APPLICATION OF CATALYZED REACTIONS TO SEMIQUANTITATIVE DETERMINATION ON THE RING OVEN. Weisz, H.; Pantel, S.; Vereno, I. (Univ., Freiburg i. B.). Mikrochim. Acta; 2: No. 3, 287-296(1975). (In German).

Catalyzed reactions can be used in combination with the ring oven for qualitative and quantitative methods. The so called simultaneous comparison method has been combined with the ring oven technique; this offers the possibility of a very simple and extremely sensitive method for determining catalytic active substances as well as inhibitors. The determination of nanogram amounts of various ions (V, Mo, Cu, Co, hexacyanoferrate(II), Ag and L-cystine) with the aid of this procedure is described. (auth)

## *Radiometric and Radiochemical Procedures*

*Refer also to abstracts 28044, 28056, 28059, and 28624.*

**27535** (IEA-42) NONDESTRUCTIVE $^{235}U$ ENRICHMENT ASSAY BY GAMMA SPECTROMETRY. Cesar, M. F.; Mafra, O. Y. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1974. 16p. (In Portuguese). Dep. NTIS (US Sales Only) $4.00.

The development at the IEA, as a routine, of the nondestructive uranium-235 enrichment assay by gamma spectrometry is discussed. Samples of known enrichment have been analyzed and the results obtained presented about 1% precision. (auth)

**27536** (SAND-75-5573) APPLICATIONS OF ION BEAM ANALYSIS TO INSULATORS. Borders, J. A.; Arnold, G. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 19p. (CONF-750949-1). Dep. NTIS $4.00.

From international conference on ion beam surface layer analysis; Karlsruhe, F. R. Germany (15 Sep 1975).

The use of ion analysis and ion analysis combined with ion implantation in insulators is reviewed. New data are presented illustrating compositional analysis of multicomponent glass systems. Studies of diffusion in insulators are illustrated with data from Ag-implanted lithia–alumina–silica glass. Problems such as sample charging and effects due to energy deposited into electronic processes are also discussed. (auth)

**27537** ANALYTICAL USE OF PROTON-INDUCED X-RAY EMISSION. Johansson, T. B. (Univ. of Lund, Sweden); Akselsson, R.; Ahlberg, M.; Johansson, G.; Malmquist, K. Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 31(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27538** DETERMINATION OF ppb CONCENTRATIONS OF TRANSITION METALS BY RADIOISOTOPE-EXCITED ENERGY-DISPERSIVE X-RAY SPECTROMETRY. Pradzynski, A. H.; Henry, R. E.; Stewart, J. L. S. (Univ. of Texas, Austin). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 34-35(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27539** AEROSOL WITHIN A COPPER SMELTER ANALYZED BY PROTON-INDUCED X-RAY FLUORESCENCE AND CALORIMETRY. Hill, M. W. (Brigham Young Univ., Provo, UT); Eatough, D. J.; Hansen, L. D.; Nielson, K. K.; Mangelson, N. F.; Smith, T. J. Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 35-36 (1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27540** BROMINE AND LEAD RELATIONSHIPS WITH PARTICLE SIZE AND TIME ALONG AN URBAN FREEWAY. Desaedeleer, G. C. (Florida State Univ., Tallahassee); Winchester, J. W.; Akselsson, R.; Hardy, K. A.; Nelson, J. W. Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 36-37(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27541** MODELS FOR CORRECTING BACKSCATTER NON-LINEARITIES IN XRF PULSE-HEIGHT SPECTRA. Arinc, F.; Gardner, R. P. (North Carolina State Univ., Raleigh). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 37-38(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27542** MONTE CARLO MODELS FOR THE INVERSE CALCULATION OF MULTIELEMENT AMOUNTS IN XRF ANALYSIS. Hawthorne, A. R.; Gardner, R. P. (North Carolina State Univ., Raleigh). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 38-39(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27543** SIMPLE ACCURATE MODEL FOR CORRECTING XRF PULSE-HEIGHT SPECTRA FOR PULSE PILEUP. Wielopolski, L.; Gardner, R. P. (North Carolina State Univ., Raleigh). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 39-41(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**27544** DETERMINATION OF PHOSPHORUS-32 ACTIVITY BY MEANS OF CHERENKOV-RADIATION. Rowinska, L.; Jakolska, H.; Radwan, M. (Inst. fuer Kernforschung, Warsaw). Isotopenpraxis; 11: No. 6, 223-225(Jun 1975). (In German).

A method to determine 32p activity by means of Cherenkov radiation is reported. The measurement yield and detection limit obtained with the SL 30 spectrometer have been compared with the corresponding values yielded by Geiger-Mueller counters and liquid scintillators. The determination of the concentration profile of 3 in semiconductor silicon is discussed as an example to characterize the measuring technique and the impact of the liquid level in the measuring flask on the yield of measurement. (auth)

**27545** TRACE ELEMENT ANALYSIS BY X-RAY FLUORESCENCE WITH AN EXTERNAL PROTON BEAM. Seaman, G. G.; Shane, K. C. (Kansas State Univ., Manhattan (USA). Dept. of Physics). Nucl. Instrum. Methods; 126: No. 3, 473-474(15 Jun 1975).

Proton-induced x-ray fluorescence was performed with 3-MeV protons passed through thin foils onto samples in air, allowing wet samples to be studied easily. (auth)

**27546** USE OF CHELATING ION-EXCHANGE RESIN IN THE DETERMINATION OF URANIUM IN GROUND WATER BY X-RAY FLUORESCENCE. Hathaway, L. R.; James, G. W. (Univ. of Kansas, Lawrence). Anal. Chem.; 47: No. 12, 2035-2037(Oct 1975).

A method developed to survey uranium concentrations in alkaline earth-bicarbonate type ground waters of western Kansas is described. (LK)

**27547** X-RAY FLUORESCENCE SPECTROMETRIC DETERMINATION OF GOLD, BROMINE, AND IODINE BIOLOGICAL FLUIDS. Purdham, J. T. (Univ. of Alberta, Edmonton); Strausz, O. P.; Strausz, K. I. Anal. Chem.; 47: No. 12, 2030-2032(Oct 1975).

Results show that for biological fluids such as serum and urine, solvent evaporation is unnecessary at the concentration levels commonly encountered with drug metabolites, and that the bromine and iodine concentrations can be measured directly in the sample, thereby significantly reducing analysis time. A rapid and relatively simple method for the determination of gold in serum is reported. Sulfide precipitation, after digestion, was used as the means of concentration. (LK)

**27548** USE OF THE CHERENKOV EFFECT IN THE COUNTING OF $\beta$- AND $\gamma$-EMITTING RADIONUCLIDES. Gelsema, W. J.; de Ligny, C. L.; Luten, J. B.; Vossenberg, F. G. A. (State Univ., Utrecht). Int. J. Appl. Radiat. Isot.; 26: No. 8, 443-450(Aug 1975).

In a transparent medium, $\beta$-radiation and the electrons which are released under certain conditions by the interaction of $\gamma$-radiation with the medium cause Cherenkov-radiation. The intensity of this Cherenkov radiation was measured in water, glycerol and saturated sodium iodide solution in water. The counting efficiency, the sensitivity and the accuracy of the Cherenkov counting method for both $\beta$ and $\gamma$-emitting radionuclides in aqueous samples were compared with those associated with competing counting methods. It is concluded that Cherenkov counting has some distinct advantages over liquid scintillation counting and sodium iodide well crystal counting for routine measurements on large aqueous samples containing activities well above background. (auth)

**27549** APPLICATIONS OF RADIONUCLIDES IN CHEMISTRY AND ENGINEERING. Kosmowski, A. (Frieseke und Hoepfner G. m. b. H., Erlangen (F. R. Germany)). CZ-Chem.-Tech.; 2: No. 9, 375-377(1973). (In German).

Current application examples are briefly described: wall thickness measurements of plastic pipes and blow foils, thickness measurements of light metal foils, density measurements in pipelines, level measurements in containers, packages, bottles, boxes, and cans, radiometric dust measurements at off-gas stacks, radionuclides as tracers and indicators and in chemical analysis. (GE)

**27550** RADIOACTIVE LIQUID COLUMN CHROMATOGRAPHY. I. Trials on the Continuous Monitoring of $\beta$-Radioactivity in LC Eluates. Figge, K.; Piater, H. (Natec - Gesellschaft fuer Naturwissenschaftlich-Technische Dienste m. b. H., Hamburg (F. R. Germany)); Kolbe, W. (Laboratorium Prof. Dr. Berthold, Wildbad (F. R. Germany)). G-I-T (Glas- Instrum.-Tech.). Fachz. Lab.; 19: No. 3, 192-202(Mar 1975). (In German).

In order to monitor the $^{14}C$-radioactivity in the eluate of a LC-column continuously, two types of flow-cells were constructed from teflon material. The flow-cell filled with glass scintillator beads exhibited a counting efficiency of 11.5%, whereas the cell in which a mixture of the scintillator and test liquids flow continuously exhibited a counting efficiency of nearly 100%. However, the flow-cell filled with glass scintillator beads is more suitable for the RLC, since no additional batching pump system is required for the scintillator liquid, the counting efficiencies are independent of the type of eluant, and no loss of separated substances occur. Since, in case of measuring $^{3}H$-radioactivities in column eluates, the counting efficiency with the flow-cell filled with glass scintillator beads was below 0.1%, only a mixing of scintillator liquids with the eluates seems to be of any use in this particular case. (auth)

**27551** DEVICE FOR CONTINUOUS RADIOMETRIC DETERMINATION OF THE CALCIUM AND IRON CONTENT IN RAW SLURRY FOR CEMENT. Wasilewska, M.; Ostachowicz, J. (Institute of Nuclear Physics and Techniques, Krakow (Poland)); Lankosz, M.; Molodynska, W. (Instytut Przemyslu Materialow Wiazacych Budowlonych, Krakow (Poland)). Zem.-Kalk-Gips; 28: No. 2, 80-83(Feb 1975). (In German).

6 figs.; 5 refs.

The characteristic Fe and Ca-K series were excited using a Cd-109 isotope source. In order to determine the Ca and Fe content in dry slurry, the Compton-effect scattered radiation of the Cd-109 source in the sample was used. A numerical process was worked out which allowed the elimination of the influence of changing contents of Fe and water on the results of the Ca content determinations, and a device for continuous radiometric determination of Ca and Fe in raw slurry was designed and constructed. The device was installed in the cement plant "Przyjazn" under technical measuring conditions and its applicability was tested. (auth)

**27552** ANALYSIS OF ARSENIC RANGE DISTRIBUTIONS IN SILICON. Sigmon, T. W. (Hewlett-Packard Co., Palo Alto,

Calif. (USA)); Chu, W. K.; Mueller, H.; Mayer, J. W. (California Inst. of Tech., Pasadena (USA)). Appl. Phys.; 5: No. 4, 347-350(Jan 1975).

3 figs.; 1 tab.; 20 refs.

MeV $^4$He ion backscattering and differential sheet resistivity measurements were made on As implants into silicon at room temperature. Analysis of backscattering measurements yields the projected range Rsub(p) and projected standard deviation ΔRsub(p). Over the energy range of 50 to 250 keV, the values of Rsub(p) agree well with LSS theoretical predictions; however, values of ΔRsub(p) are systematically higher than theoretical calculations. Backscattering and differential sheet resistivity measurements on samples annealed at 950°C are in general agreement and indicate diffusional broadening of the profile. (auth)

**27553** EXPERIMENTAL METHOD FOR MEASURING BOTH ATOM AND CARRIER CONCENTRATION PROFILES IN THE SAME SAMPLE OF ION-IMPLANTED SILICON LAYERS BY RADIOACTIVE-ION IMPLANTATION. Iwaki, M.; Gamo, K.; Masuda, K.; Namba, S. (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science); Ishihara, S.; Kimura, I. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.); Yokota, K. (Kansai Univ., Suita, Osaka (Japan). Faculty of Engineering). Nucl. Instrum. Methods; 127: No. 1, 93-98(15 Jul 1975).

An experimental method using radioactive-ion implantation for measuring both atom and carrier concentration profiles in the same sample of ion-implanted silicon layers is presented. Radioactive-ion implantation apparatus and a sample holder are produced for profiling operations. Atom and carrier concentration profiles are obtained by using successive layer-removal techniques that involve anodic oxidation and oxide-layer removal by hydrofluoric acid: atom concentration profiles by measuring gamma rays from radioactive impurities in the solution of hydrofluoric acid, and carrier concentration profiles from Hall-effect and sheet-resistivity measurements. This technique is applied to arsenic-ion implantation in silicon, and some results are discussed. (auth)

## Separation Procedures

*Refer also to abstract 27904.*

**27554** (AECL-4932) RADIANT STILL. Bayly, J. G.; Gresham, D.; Kolk, J. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). May 1975. 38p. Dep. NTIS (US Sales Only) $5.00. AECL $1.00.

A novel distillation method for preparing a water sample for an isotopic analyzer was developed. Because only the upper surface of the water is heated, one stage of distillation can produce clean distillate with a short time delay, less isotopic fractionation and less dissolved gases than a conventional still, and good immunity to the accumulation of contaminants. (auth)

**27555** (ANL-Trans-990) INTERFACIAL MASS TRANSFER DURING EXTRACTION OF TRACES OF HEXAVALENT URANIUM AND TETRAVALENT PLUTONIUM WITH TRIBUTYLPHOSPHATE. Moszkowicz, P.; Kikindai, T. Translated from C. R. Hebd. Seances Acad. Sci., Ser. C; 280: 321-324(10 Feb 1975). 7p. Dep. NTIS $4.00.

The interfacial reactions for the extraction of hexavalent uranium and tetravalent plutonium with tributylphosphate (TBP) are of first order relative to the neutral species of the metal in the aqueous phase and second order relative to the extractant. The limiting step is complexing at the interface by two TBP molecules. The influence of temperature was investigated. (auth)

**27556** (CEA-Bib-212(2)) SOLVENT EXTRACTION OF ZINC AND METALS FROM MINES BY NONPHOSPHOROUS SOLVENTS. Auchapt, J. M.; Tostain, J. (CEA Centre de Marcoule, 30 - Bagnols-sur-Ceze (France). Section de Genie Chimique Industriel; CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Documentation). Jul 1975. 123p. (In French). Dep. NTIS (US Sales Only) $9.25.

This bibliography follows a first work on the solvent extraction of zinc by organophosphorous compounds. All the solvents used in the extraction, are studied. They are classed as oxygenated nonphosphorous solvents (ketones – alcohols – carboxylic acids – sulfonates), nitrogenous solvents and hydrocarbons. (auth)

**27557** (INIS-mf-1721) STUDY OF SOLVENT EXTRACTION OF THE LANTHANIDE ELEMENTS, SCANDIUM, URANIUM AND THORIUM USING TETRACYCLINE AS THE COMPLEXING AGENT. Nastasi, M. J. C. (Sao Paulo Univ. (Brazil). Instituto de Quimica). 1974. 107p. (In Portuguese). INIS.

The formation of complex compounds between the lanthanide elements, uranium or thorium and tetracycline was verified by spectrophotometric techniques. Solvent extraction of these compounds was studied with benzyl alcohol used as the diluent. The extraction dependence on the pH of the aqueous phase as well as on the extractant concentration of the organic phase was determined. As a practical application, the possibility of using a tetracycline–benzyl alcohol system for separation of the lanthanide elements present in a mixture of them, as well as for the separation of uranium from those elements, was tested. In the first case the discontinuous countercurrent solvent extraction was the method of choice. And on the second case, the single solvent extraction operation was used. Radioactive tracers of the elements considered were used to carry on the solvent extraction studies. Concentrations of uranium were determined by activation analysis, due to the unavailability of long lived uranium radioisotopes with easily measureable radiation. (INIS)

**27558** (NIIAR-P-224) INFLUENCE OF ZIRCONIUM-PHOSPHATE TREATMENT ON EFFICIENCY OF AMERICIUM(5) SEPARATION FROM CURIUM(3) AND EVOLUTION OF BERKELIUM(4) AND CERIUM(4). Shafiev, A. I.; Efremov, Yu. V.; Yakovlev, G. N. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1974. 11p. (In Russian). INIS.

Data are presented that show the effect of the method of processing of zirconium phosphate on the efficiency of separation of Am(V) and from Cm(III), and of Bk(IV) from Ce(IV). Impurities with reducing properties in the zirconium phosphate may be removed by a several-cycle treatment, e.g., dissolving in 1N $HNO_3$ and 5% $(NH_4)_2S_2O_3$ at 80-90°C and then in 1N $HNO_3$ followed by drying in air and heating at 100-270°C for 5-7 hr. For separating Am(V) from Cm(III) the sorbent must be converted to the cation form. (tr-auth)

**27559** SORPTION OF $UO_2^{2+}$ AND $Th^{4+}$ IONS ON SILIGA GEL IN THE PRESENCE OF SOME POLYAMINOPOLYCARBOXYLIC ACIDS. Sulcek, Z.; Sixta, V. (Geological Survey of Czechoslovakia, Prague). Collect. Czech. Chem. Commun.: 40: No. 8, 2295-2302(Aug 1975).

Distribution coefficients of $UO_2^{2+}$ and $Th^{4+}$ ions were determined for the system silica gel-aqueous solutions of several polyaminopolycarboxylic acids, citric acid and tartaric acid. The corresponding separation factors were calculated for $I \leq 0.1$ and $I = 1$. (auth)

**27560** CHROMATOGRAPHIC SEPARATION OF URANIUM FROM EXCESS OF THORIUM ON SILICA GEL COLUMN. Sulcek, Z.; Sixta, V. (Geological Survey of Czechoslovakia, Prague). Collect. Czech. Chem. Commun.; 40: No. 8, 2303-2308(Aug 1975).

Conditions were found for the chromatographic separation of uranium from excess of thorium on a column of silica gel from the medium of triethylenetetraminehexaacetic acid (TTHA), diethylenetriaminepentaacetic acid (DTPA), and nitrilotriacetic acid (NTA). Under optimum conditions, i.e. from the TTHA medium of pH 5–6 and I = 1, uranium may efficiently be separated from the $8 \times 10^4$ excess of thorium. (auth)

**27561** RECOVERY OF COBALT-RARE EARTH ALLOY PARTICLES BY HYDRATION-DISINTEGRATION IN A MAGNETIC FIELD. McFarland, C. M.; Lerman, T. B.; Rockwood, A. C. (to General Electric Company). US Patent 3,878,000. 15 Apr 1975. Filed date 3 Jun 1974. 8p.

A process for recovering magnetic alloy particles from a reaction product cake. The cake is placed in a reactor where it is contacted with a flowing water vapor-carrying gas which reacts with its calcium content to disintegrate the cake and produce a hydrated powder comprised substantially of calcium hydroxide and the alloy particles. A magnetic zone is generated into a cross-section of the reactor substantially encircling the inside wall thereof. The zone is generated by at least two poles of opposite polarity running the length of the zone. The hydrated powder is fluidized to dissociate and pass the calcium hydroxide out of the reactor. Finer-sized alloy particles carried by the fluidizing gas into the magnetic zone are subjected to the magnetic field where the poles are rotated or reversed at a rate which reverses the positions of the particles sufficiently to release adherent calcium hydroxide leaving the finer-sized alloy particles substantially within the magnetic zone. (auth)

**27562** DILUTED TRIBUTYL PHOSPHATE AS AN EXTRACTANT FOR BERYLLIUM AS ITS THIOCYANATE COMPLEX. Kalyanaraman, S.; Khopkar, S. M. (Indian Inst. of Tech. Powai). Anal. Chem.; 47: No. 12, 2041-2042(Oct 1975).

A method for the solvent extraction of beryllium from thiocyanate media with 50 percent TBP, using toluene as a diluent is described. The proposed method is simple, rapid, selective, and applicable at microgram concentrations. (LK)

**27563** EXTRACTION OF METAL IONS WITH N,N-DISUBSTITUTED AMIDES. Fritz, J. S.; Orf, G. M. (Ames Lab., IA). Anal. Chem.; 47: No. 12, 2043-2045(Oct 1975).

N,N-dibutylformamide, N,N-dihexylacetamide, and N,N-diethyldodecarbamide were studied as solvents for liquid–liquid extraction of Al, Ca, Cd, Co, Cu, Fe, Hg, Mg, Ni, Pb, Th, U, Zn, and Zr from nitrate and perchlorate solutions. (LK)

**27564** USE OF CELLULOSE PHOSPHATE FOR SORPTION OF MICROQUANTITIES OF ZIRCONIUM, TITANIUM, AND IRON. Kalinina, T. I.; Tyutina, N. A. J. Appl. Chem. USSR (Engl. Transl.); 48: No. 3, 613-615(Mar 1975).

Translated from Zh. Prikl. Khim.; 48: No. 3, 599-601(Mar 1975).

Cellulose phosphate can be used for sorption of microquantities of $Zr^{4+}$ from acid solutions. It is possible to separate microquantities of $Zr^{4+}$ from macroquantities of ions such as $Ti^{4+}$, $Fe^{3+}$, and $Ba^{2+}$. Zirconium can be desorbed from cellulose phosphate by ammonium carbonate solution, and then determined colorimetrically with Arsenazo III. Cellulose phosphate can be used for separating microquantities of $Ti^{4+}$ from $Fe^{3+}$ ions, and microquantities of $Fe^{3+}$ from $Ba^{2+}$ ions. Ammonium carbonate solution can also be used for desorbing $Ti^{4+}$ and $Fe^{3+}$ ions. (auth)

**27565** ANION-EXCHANGE SEPARATION OF PLUTONIUM IN HYDROCHLORIC–HYDROBROMIC ACID MEDIA. Larsen, R. P.; Oldham, R. D. (Argonne National Lab., IL). Talanta; 22: No. 7, 577-580(Jul 1975).

Plutonium can be rapidly and selectively separated from the elements that interfere in its radiochemical determination, by the use of hydrobromic acid in a hydrohalic acid anion-exchange separation procedure. Plutonium(IV) and (VI) are adsorbed onto the resin column from 9M hydrochloric acid, interfering elements such as americium and thorium are washed from the column with 9M hydrochloric acid, and the plutonium is reduced to plutonium (III) and washed from the column with 11M hydrobromic acid. Interfering elements such as uranium and neptunium, which are adsorbed onto the column from 9M hydrochloric acid, are retained there during the hydrochloric and hydrobromic acid washes. This system would also appear to provide the means for effectively separating plutonium from those elements that commonly interfere in such chemical methods of analysis as redox titration. (auth)

**27566** ELECTROCHEMICAL AND SPECTROSCOPIC STUDIES OF SOME ZIRCONIUM AND HAFNIUM COMPOUNDS IN ACETONITRILE. Zink, E. W. Amherst, MA; University of Massachusetts (1975). 201p. University Microfilms Order No. 75-16,618.

Thesis (Ph. D.).

The electrochemical behavior of zirconium and hafnium tetrachloride in acetonitrile was investigated with the goal of accumulating sufficient information to effect their separation. In 0.1 F tetraethylammonium bromide (TEABr) zirconium tetrachloride was found to undergo a four electron reduction at –1.87 volts versus S.C.E. The single polarographic reduction wave is irreversible. Paramagnetic titanium species were produced by chemical reduction of acetonitrile solutions of $TiCl_4$ with sodium amalgams and detected by electron spin resonance (ESR) techniques. Paramagnetic zirconium and hafnium species were produced by chemical reduction of their acetonitrile solutions with sodium amalgams and by electrolysis at a mercury cathode with no supporting electrolyte present. It was concluded that Ti III, Zr III, and Hf III species had been produced based on the ESR signals observed. Raman spectroscopic studies of acetonitrile solutions of zirconium and hafnium tetrachloride showed that at least three chloro species of the metals existed in equilibrium with each other. Comparison of Raman data with published infrared results leads to the conclusion that the compound $MCl_4 \cdot 2CH_3CN$ (M equals Zr, Hf) has the two acetonitrile ligands cis to each other, and symmetry of the compound is probably C/sub 2v/. nu$_1$ for the solid $ZrCl_4 \cdot 2CH_3CN$ is at 358 $cm^{-1}$ and for the solid $HfCl_4 \cdot 2CH_3CN$ is at 352 $cm^{-1}$. Splitting of $CH_3CN$ fundamentals was observed for $MCl_4 \cdot 2CH_3CN$ (M equals Zr, Hf) but not for the corresponding pentachloro species. (Diss. Abstr. Int., B)

**27567** COMPLEXOMETRIC BEHAVIOR OF SOME 2-MERCAPTO-p-CRESOLS. I. Gagliardi, E.; Reiterer, H. D. (Univ., Graz). Mikrochim. Acta; 2: No. 3, 297-309(1975). (In German).

The behavior of various elements with substituted 2-mercaptocresols were investigated. Colored chelates appeared besides mercaptides. The possibility of extractions, a spectrophotometric determination of tungsten, the preparation of some metal-ligand-compounds and a TLC-separation were described. (auth)

# Inorganic, Organic, and Physical Chemistry

## Chemical and Physicochemical Properties

*Refer also to abstracts 27506, 27639, 27652, 27697, 28397, 28446, 28697, 29308, and 30218.*

**27568** (AE-504) ANALYSIS OF EPR WITH LARGE QUADRUPOLE INTERACTION. Thuomas, K. A. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1975. 30p. Dep. NTIS (US Sales Only) $4.50.

A method was developed to analyze EPR spectra for the case when the quadrupole coupling and the hyperfine coupling are of comparable magnitudes but much smaller than the electronic Zeeman term. A computer program that calculates the EPR spectrum for a finite Gaussian or Lorentzian line width was written. The program is particularly suitable for cases with several interacting nuclei. The method was applied to confirm the planar structure of the $CHCl_2$. radical. Ab initio UHF calculations have further confirmed this structure. (auth)

**27569** (JINR–R-14-8156) ANALYSIS OF THE EXPERIMENT ON INELASTIC NEUTRON SCATTERING ON CRYSTAL LEVELS OF $Pr^{3+}$ IN $PrF_3$. Welsch, D.; Mattkhiz, S.; Hennig, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 20p. (In Russian). INIS.

In order to determine the energy of the electron levels of the lower multiplet of $Pr^{3+}$ dispersed by the effect of a crystalline field in $PrF_3$, the experimental spectrum of inelastic dispersion of thermal neutrons at these levels was set up theoretically. (tr-auth)

**27570** (ORNL-5011, pp 20-55) CHEMISTRY. Ferris, L. M. Jun 1975.

In molten-salt reactor program. Semiannual progress report for period ending August 31, 1974. (Oak Ridge National Lab., Tenn. (USA)).

Research and development activities dealing with the chemical problems related to design and ultimate operation of molten-salt reactor systems are described. An experimental test stand was constructed to expose metallurgical test specimens to $Te_2$ vapor at defined temperatures and deposition rates. To better define the chemistry of fluoroborate coolant, several aspects are being investigated. The behavior of hydroxy and oxy compounds in molten $NaBF_4$ is being investigated to define reactions and compounds that may be involved in corrosion and/or could be involved in methods for trapping tritium. Two corrosion products of Hastelloy N, $Na_3CrF_6$ and $Na_5Cr_3F_{14}$, were identified from fluoroborate systems. The evaluation of fluoroborate and alternate coolants continued. Research on the behavior of hydrogen and its isotopes is summarized. The solubilities of hydrogen, deuterium, and helium in $Li_2BeF_4$ are very low. The sorption of tritium on graphite was found to be significant (a few milligrams of tritium per kilogram of graphite), possibly providing a means of sequestering a portion of the tritium produced. Development of analytical methods continued with emphasis on voltammetric and spectrophotometric techniques for the in-line analysis of corrosion products such as $Fe^{2+}$ and $Cr^{3+}$ and the determination of the $U^{3+}/U^{4+}$ ratio in MSBR fuel salt. Similar studies were conducted with the $NaBF_4$–NaF coolant salt. Information developed during the previous operation of the CSTF has been assessed and used to formulate plans for evaluation of in-line analytical methods in future CSTF operations. Electroanalytical and spectrophotometric research suggests that an electroactive protonic species is present in molten $NaBF_4$–NaF, and that this species rapidly equilibrates with a volatile proton-containing species. Data obtained from the CSTF indicated that tritium was concentrated in the volatile species. (JGB)

**27571** (ORNL-5011, pp 56-98) MATERIALS DEVELOPMENT. McCoy, H. E. Jun 1975.

In molten-salt reactor program. Semiannual progress report for period ending August 31, 1974. (Oak Ridge National Lab., Tenn. (USA)).

Tests on the weldability and mechanical properties of Hastelloy N are reported. Transmission electron microscopy was used to characterize the microstructure of Ti-modified Hastelloy N alloys. Molten salt and steam corrosion studies are also reported. Work on chemical processing materials is concentrated on graphite. Results of studies on the extent of penetration of graphite by Bi and Bi–Li solutions at 650°C are reported. Properties of neutron-irradiated graphite are tabulated. (JGB)

**27572** (ORNL-5047, pp 36-58) CHEMISTRY. Ferris, L. M. Sep 1975.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1975. (Oak Ridge National Lab., Tenn. (USA)).

The chemical research and development efforts related to the design and ultimate operation of molten-salt breeder reactor systems are concentrated on fuel- and coolant-salt chemistry, including the development of analytical methods for use in these systems. The chemistry of tellurium in fuel salt is being studied to help elucidate the role of this element in the intergranular cracking of Hastelloy N. Studies were continued of the effect of

oxygen-containing species on the equilibrium between dissolved $UF_3$ and dissolved $UF_4$, and, in some cases, between the dissolved uranium fluorides and graphite, and the $UC_2$. Several aspects of coolant-salt chemistry are under investigation. Hydroxy and oxy compounds that could be formed in molten $NaBF_4$ are being synthesized and characterized. Studies of the chemistry of chromium (III) compounds in fluoroborate melts were continued as part of a systematic investigation of the corrosion of structural alloys by coolant salt. An in-line voltammetric method for determining $U^{4+}/U^{3+}$ ratios in fuel salt was tested in a forced-convection loop over a six-month period. (LK)

**27573** (RI-11) ON CHANGE OF STABILITY OF S- AND P- ELEMENT COMPOUNDS. Chajkhorskij, A. A. (Radievyj Inst., Leningrad (USSR)). 1973. 16p. (In Russian). INIS.

Comparison of the heats of formation of atoms, positively and negatively charged ions, fluorides, chlorides, bromides, iodides, oxides, sulfides, nitrides, and hydrides of s- and p-elements showed that the maximum possible degree of oxidation of elements and the stability of their compounds depends on the value of the fifth quantum number. When an activated octet configuration is achieved, changes occur in the fifth quantum number, which results in a change in stability of the compound. (tr-auth)

**27574** REDOX BEHAVIOR OF MOLYBDENUM IN AQUEOUS MEDIUM, A POTENTIOMETRIC STUDY. Sagi, S. R.; Mohan Rao, P. R. (Andhra Univ., Waltair, India). Indian J. Chem.; 13: No. 6, 581-585(Jun 1975).

The nature of the two forms of Mo(III) [cationic-aquomolybdenum (III) (green) and anionic-chloromolybdate(III) (orange-red)] has been investigated using various oxidants in hydrochloric acid medium, the oxidation steps being detected using a potentiometric method. The two species behave differently towards the various oxidants. The green form is a better reducing agent giving large breaks in potentials during redox titrations. The existence of the intermediate oxidation states $Mo^{3.5}$ and $Mo^{4.5}$, reported earlier has also been confirmed. (auth)

**27575** NMR IN THE NEW PHASES OF $^3He$: A UNIQUE SITUATION. Leggett, A. J. (Sussex Univ., Brighton (UK). School of Mathematical and Physical Sciences). pp 31-34 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th Ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The anomalous NMR behavior of the new A and B phases of liquid $^3He$ is described and shown to imply a probably unique type of ordering. The physical basis of a theory based on the anisotropic-superfluid model is outlined. (auth)

**27576** BINDING SYSTEMS OF BORON WITH THE ELEMENTS SULFUR, SELENIUM, AND TELLURIUM. Siebert, W. (Marburg Univ. (F. R. Germany). Fachbereich Chemie). Chem. Ztg.; 98: No. 10, 479-486(Oct 1974). (In German).

The synthesis and properties of boron compounds with B-S, B-Se and B-Te bonds are reported. The main part of this survey covers monomeric boron compounds, in particular cyclic and chain-like systems. Besides binary compounds and metal-chalcogenoborates, also donor-acceptor complexes and thioboranes as ligands are described. The nature of the boron chalcogen bond is discussed. (auth)

**27577** PREPARATION AND LATTICE PARAMETERS OF CURIUM SULFIDES AND SELENIDES. Damien, D. (CEA-CEN, Fontenay-aux-Roses, France); Charvillat, J. P.; Mueller, W. Inorg. Nucl. Chem. Lett.; 11: No. 7-8, 451-457(Jul 1975).

The preparation and x-ray characterization of curium sulfides and selenides is described. Substoichiometric disulfide and diselenide crystallize in the tetragonal system, presumably of $Fe_2As$ type. Body-centered cubic sesquisulfide and sesquiselenide exhibit the defect $Th_3P_4$ structure type. Curium oxysulfide $Cm_2O_2S$ is isostructural with hexagonal plutonium oxysulfide. (auth)

**27578** PRECIPITATION KINETICS OF $CaCO_3$ IN PRESENCE OF $Mg^{2+}$ IONS. Moeller, P.; Rajagopalan, G. (Hahn-Meitner-Institut fuer Kernforschung Berlin G. m. b. H. (F. R. Germany)). Z. Phys. Chem. (Frankfurt); 94: No. 4-6, 297-314(Feb 1975).

The various stages of the precipitation process of calcite, Mg-calcites and aragonite have been followed by the homogeneous precipitation technique from solution using Ca-45 as tracer. The change of $CaCO_3$ modifications in precipitation was caused by increasing the Mg/Ca molar ratio of solutions. (auth)

**27579** INFLUENCE OF RADIATION STERILIZATION ON THE MEDICOCHEMICAL PROPERTIES OF POLYMER MATERIALS COMING INTO CONTACT WITH MEDICAL PRODUCTS. Semenenko, E. I.; Polunin, V. A.; Markelov, M. A. (All-Union Scientific Inst. for Medical Polymers, Moscow). pp 171-176 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Russian)

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

In view of the ever-increasing use of radiation for sterilizing medical products it is of interest to study the effect of ionizing radiation on the medicochemical properties of these substances, in particular polymer materials that come into contact with biological and medicinal media. In this paper the authors study how radiation affects the migration of monomers from such widely used polymers as polystyrene and copolymers of methyl methacrylate. A direct relationship is established between the concentration of monomers in polymers and the extent of their migration into standard media. It is shown that both gamma radiation and accelerated electrons tend to reduce the unpolymerized monomer content of a polymer. A mechanism for the process is proposed, based on the relationship established between the monomer content of polymers and the dose-rate. (auth)

**27580** KINETICS OF THE ACCUMULATION OF MOLECULAR NITROGEN $N_2$ AND NITROUS OXIDE $N_2O$ AS A FUNCTION OF THE PRESSURE IN THE SYSTEM $2NO_2$ REVERSIBLE $2NO + O_2$. Gvozdev, A. A.; Nesterenko, V. B.; Nichipor, G. V.; Trubnikov, V. P. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 32-39(1975). (In Russian).

Experimental data on formation kinetics of $N_2$ and $N_2O$ in the system $2NO_2 \rightleftarrows 2NO + O_2$ under static condition over the pressure range between 20 and 50 atm at 500°C were obtained. A probable mechanism of formation of $N_2O$ following the reaction $2NO_2 \rightarrow N_2O + O_2$ is suggested and the constant of the reaction rate is estimated. Kinetics of the process were calculated on an electronic digital computer according to the suggested mechanism. The predictions agree well with the experiment. (auth)

**27581** LIFETIMES OF EXCITED STATES IN $D_2O^+$ AND $OD^+$ AND RELATIVE LIFETIMES BETWEEN THE NORMAL AND DUETERATED SPECIES. Brzozowski, J.; Erman, P. (Research Institute for Physics, Stockholm, Sweden); Lew, H. (National Research Council of Canada, Ottawa, Ontario. Div. of Physics). Chem. Phys. Lett.; 34: No. 2, 267-270(15 Jul 1975).

Absolute lifetimes of excited states of $D_2O^+$ and $OD^+$ were directly measured using the high frequency deflection technique. Separate relative measurements show that the $D_2O^+$ and $OD^+$ lifetimes are 13-8% longer than those of $H_2O^+$ and $OH^+$ in the same vibrational levels. (auth)

## Isotope Effects

*Refer also to abstracts 27526, 27641, 27674, 28446, 29676, and 30220.*

**27582** (INIS-mf-1685) ISOTOPE EFFECT IN THE SORPTION OF HYDROGEN ON TITANIUM. Millenbach Paulina. (Tel Aviv Univ. (Israel)). Sep. 1974. 47p. (In Hebrew). INIS.

Titanium adsorbs hydrogen up to a maximum composition of $TiH_2$. Thermodynamic quantities in the titanium-hydrogen system were obtained from dissociation pressures of the hydrides. There exists some evidence that the dissociation pressures of the deuterides are higher than those of the corresponding hydrides. No experiments in isotope exchange were previously conducted on the hydrogen-titanium system. This work consisted of such experiments in order to find whether there exists an isotope effect in the adsorption of hydrogen. The experiments included adsorption of mixtures and exchange of one isotope by the other. The experiments proved the existence of a definite isotope effect. The energy of exchange is 0.5 kcal/mole. (INIS)

**27583** REVERSIBLE HYDRATION OF PTERIDINE. General Acid-Base Catalysis, Solvent Deuterium Isotope Effects, and Transition State Characterization. Pocker, Y.; Bjorkquist, D.; Schaffer, W.; Henderson, C. (Univ. of Washington, Seattle). J. Am. Chem. Soc.; 97: No. 19, 5540-5546(17 Sep 1975).

The hydration of pteridine was investigated over the pH range 1 to 10 at 25.0°, utilizing a spectrophotometric method. Above pH 7.5, the hydration of this heterocyclic Schiff base is catalyzed by hydroxide ions and by the basic component of a number of buffers (imidazole, 1,2-dimethylimidazole, borate, carbonate, triethylamine). The general base catalysis conforms to a Bronsted plot with an exponent beta equals 0.64 +- 0.03. Below pH 7.5, the reaction is catalyzed predominantly by hydronium ions. The value of 0.50 +- 0.02 for the ratio k/sub $H_3O^+$//k/sub $D_3O^+$/ indicates a preequilibrium protonation of pteridine. However, in a few instances, the acidic component of buffers capable of bifunctional catalysis ($H_2PO_4^-$, $H_2AsO_4^-$, and $HCO_3^-$) also exhibited an enhance-

ment in the rate of hydration. The solvent isotope effect for water catalysis, k/sub $H_2O$//k/sub $D_2O$/, has a value of 3.4 +- 0.4 which is similar to those of a number of other reactions involving water in a cyclic mechanism. (auth)

**27584** DEUTERIUM ISOTOPE EFFECTS IN THE SOLVOLYSIS OF BENZAL CHLORIDES. II. Evidence for a Change in Mechanism in the Hydrolysis of O-Carboxybenzal Chloride in Water and Water–Dioxane Mixtures. Vitullo, V. P.; Wilgis, F. P. (Univ. of Maryland, Baltimore). J. Am. Chem. Soc.; 97: No. 19, 5616-5617(17 Sep 1975).

**27585** VIBRATIONAL RELAXATION IN LIQUIDS. Some Applications of The Isotopic Dilution Method. van Woerkom, P. C. M.; de Bleijser, J.; de Zwart, M.; Burgers, P. M. J.; Leyte, J. C. (Rijksuniversiteit Leiden (Netherlands). Gorlaeus Labs.). Ber. Bunsenges. Phys. Chem.; 78: No. 12, 1303-1318 (Dec 1974).

The isotopic dilution method is applied to the study of the influence of intermolecular vibrational relaxation on the IR correlation functions of some absorption bands of $CH_2Cl_2$, $CHCl_3$ and $CDCl_3$. The temperature dependent isotopic dilution effect is explained on the basis of intermolecular transition dipole-transition dipole interaction, modulated by molecular reorientation. For these systems a priori separation of independent rotational and vibrational correlation functions is not permitted according to the experimental results. (auth)

**27586** NEUTRON DIFFRACTION STUDY OF PRUSSIAN BLUE, $Fe_4[Fe(CN)_6]_3 \times 14D_2O$. Buser, H. J.; Ludi, A. (Bern Univ. (Switzerland). Inst. fuer Anorganische, Analytische und Physikalische Chemie); Fischer, P.; Studach, T. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)); Dale, B. W. (UKAEA Research Group, Harwell. Nuclear Physics Div.). Z. Phys. Chem. (Frankfurt); 92: No. 4-6, 354-357(Oct 1974).

Neutron diffraction experiments were carried out with a powder sample because the crystal size of Prussian Blue is still too small for a single crystal neutron diffraction. The sample was dehydrated in vacuo and treated with an excess of $D_2O$. The neutron diffraction patterns were measured with a computer-controlled two-circle diffractometer at the reactor Diorit. The relative contribution (%) to the intensity in neutron and x-ray diffraction of the 96.8% deuterated substance occupied positions and numbers of atoms per unit cell, and the temperature dependence of the 111-intensity are described. (GE)

**27587** VAPOR PRESSURE-ISOTOPE EFFECT OF DEUTERATED N-PENTANE. Hoerner, C.; Hoepfner, A.; Schmeiser, B. (Heidelberg Univ. (F. R. Germany). Physikalisch-Chemisches Inst.). Ber. Bunsenges. Phys. Chem.; 79: No. 2, 222-225(Feb 1975). (In German).

The vapour pressure of n-pentane and the vapour pressure isotope effect of three deuterated n-pentanes ($CD_3CD_2CD_2CD_2CD_3$, $CH_3CH_2CH_2CH_2CH_2D$, $CH_3CH_2CHDCH_2CH_3$) in the temperature range between -60 and +25°C are reported. 3-$D_1$-n-pentane shows a "normal" effect below -5°C and an "invers" effect above, 1-$D_1$- and $D_{12}$-n-pentane have an inverse effect at all investigated temperatures. A comparison is made of the observed vapour pressures and the estimated enthalpies of vaporization with literature data. (auth)

**27588** VAPOR PRESSURE-ISOTOPE EFFECT OF DEUTERATED NEOPENTANE. Hoepfner, A.; Parekh, N.; Hoerner, C.; Abdel-Hamid, A. (Heidelberg Univ. (F. R. Germany). Physikalisch-Chemisches Inst.). Ber. Bunsenges. Phys. Chem.; 79: No. 2, 216-222(Feb 1975). (In German).

The vapour pressure of neopentane and the vapour pressure isotope effect of six deuterated neopentanes ($C(CD_3)_4$, $C(CH_3)(CD_3)_3$, $C(CH_3)_2(CD_3)_2$, $(CH_2D)_4$, $C(CH_3)_3(CD_3)$, $C(CH_3)_3(CH_2D)$) in the range between −60 and + 20°C are reported. All effects were found to be the opsite of those expected. The triple points were between −16.64 (for neopentane) and −18.66°C (for neopentane-$d_{12}$). A comparison was made of the observed vapour pressures and the estimated entnalpies of vaporization with literature data. (auth)

**27589** SOME ASPECTS OF THE PHOTOCHEMISTRY OF BENZENE-$D_1$. Grossman, M.; Semeluk, G. P.; Unger, I. (New Brunswick Univ., Fredericton (Canada). Dept. of Chemistry). Ber. Bunsenges. Phys. Chem.; 79: No. 2, 206-210(Feb 1975).

Emission yields of benzene-$d_1$ vapor excited at several wavelengths between 245 and 265 nm have been determined. Triplet yields based on the sensitized emission of biacetyl have been obtained. High pressure, oxygen perturbed singlet-triplet absorption spectra and the phosphorescence lifetime in EPA glass for $C_6H_5D$ have been recorded and compared to that of $C_6H_6$. The photochemistry of Boltzmann distributions of vibronic levels of $C_6H_5D$ and $C_6H_6$ are very similar. (auth)

**27590** INVESTIGATIONS ON THE REACTION OF HYDROGEN ATOMS WITH METHYLFLUORIDE, METHYL CHLORIDE, AND METHYL BROMIDE. Aders, W. K.; Pangritz, D.; Wagner, H. G. (Goettingen Univ. (F. R. Germany). Inst. fuer Physikalische Chemie). Ber. Bunsenges. Phys. Chem.; 79: No. 1, 90-94(1975). (In German).

The reactions of H atoms or D atoms with $CH_3F$, $CH_3Cl$, and $CH_3Br$ were studied between 298 and 652°K in a fast flow reactor. Stable and unstable products were measured simultaneously with high sensitivity ESR and mass spectrometry. The main products from subsequent reaction steps of all three reactions are: $CH_4$, $C_2H_6$, HX [X = F, Cl, Br] and $Br_2$ and $H_2$ in the case of $CH_3Br$. The rate coefficient of the initial steps of the reactions H + $CH_3X \rightarrow CH_3$ + HX is given in Arrhenius form. Mechanisms accounting for the observed products are discussed. (auth)

**27591** HIGHLY EFFICIENT INTRAMOLECULAR NUCLEOPHILIC REACTIONS. The Cyclization of p-Nitrophenyl N-(2-mercaptophenyl)-N-methylcarbamate and Phenyl N-(2-aminophenyl)-N-methylcarbamate. Fife, T. H.; Hutchins, J. E. C.; Wang, M. S. J. Am. Chem. Soc.; 97: No. 20, 5878-5882(1 Oct 1975).

p-Nitrophenyl N-(2-mercaptophenyl)-N-methylcarbamate cyclizes rapidly at 25° to N-methylbenzothiazolone with release of p-nitrophenol. The pH-rate constant profile is sigmoidal with pK/sub app/ equals 8.7. The effective molarity of the neighboring sulfhydryl group is $1.4 \times 10^5$ M in comparison with bimolecular attack of thiols on p-nitrophenyl N-methyl-N-phenylcarbamate. The pH-rate constant profile for cyclization of phenyl N-(2-aminophenyl)-N-methylcarbamate to 1-methyl-2-benzimidazolone is sigmoidal at 50° with pK/sub app/ of 2.7. The solvent isotope effect k/sub $H_2O$//k/sub $D_2O$/ is 1.2 for the pH-independent reaction where participation by the neighboring group is maximal. Bimolecular reaction of cyclohexylamine (pK/sub a/ equals 10.7) with phenyl N-(4-aminophenyl)-N-methylcarbamate was too slow to be accurately measured, but, employing the upper limit of a detectable second-order rate constant and a reasonable value for the Bronsted coefficient, the effective molarity of a neighboring amine group in reaction with carbamate esters was calculated to be at least $3 \times 10^8$ M. Thus, large effective molarities of $10^5$–$10^8$ M, previously observed only with oxy anion nucleophiles, can also be obtained in intramolecular reactions of neutral amine nucleophiles. The DELTA S* for intramolecular nucleophilic amine attack is −23.8 eu which implies that part of the large rate enhancement is probably due to a relatively favorable DELTA H* value. Cyclohexylamine catalyzed release of p-nitrophenoxide ion from p-nitrophenyl N-methyl-N-phenylcarbamate at 50° is characterized by DELTA S* equals −32.5 eu. (auth)

**27592** KINETIC STUDIES OF THE REACTION OF FLUORINE WITH HYDROGEN. Reid, G. P. Kensington, Australia; Univ. of New South Wales (1974). vp. Librarian, Univ. of New South Wales, Kensington, Australia.

Thesis (Ph. D.).

The competitive gas phase fluorinations of hydrogen, deuterium, methane, deuteromethane-$d_4$, ethane, propane, n-butane and chloromethane have been studied over a temperature range of about -30°C to + 75°C, using mainly the consumption method of the static competitive method. The reaction mixture was analyzed gas chromatographically for amounts of reactants consumed, and the amounts of products formed. Isothermal conditions were obtained by using a packed reaction vessel and high inert gas dilution. The measurement of kinetic isotope effects has shown that the activation energies of the hydrogen isotope species are very similar to their deuterium analogues, with a rate constant ratio, $k_H/k_D$ of 1.6-1.7, being less than that calculated from the zero-point energy difference. Hence no tunnelling appears to be present in these systems. A B.E.B.O. type calculation on the kinetic hydrogen isotope effect for the F + $H_2/D_2$, F + $CH_4/CD_4$, and F + $CHCl_3/CDCl_3$ reactions shows that this method is unsuitable for theoretical study of highly exothermic reactions. (LK)

**27593** CALCULATIONS OF THE ISOTOPE CHEMICAL SHIFTS FOR $^{13}C$, $^{14}N$, AND $^{17}O$ NUCLEI BASED ON DOUBLE PERTURBATION THEORY. Mamayev, V. M.; Sergeyev, N. M. (Moskovskij Gosudarstvennyj Univ. (USSR). Khimicheskij Fakul'tet). Chem. Phys. Lett.; 34: No. 2, 317-320(15 Jul 1975).

Isotopic substitution in a molecule may be considered as a small perturbation of the molecular geometry. In NMR terms, it may be thought of as a second perturbation operating in parallel with the first one, the magnetic field. A double perturbation theory put forward in the present paper aims at explaining isotope chemical shifts. The heavier isotopic replacement (H-D, i.e., an A-H bond is replaced by an A-D bond) was found to result in a small increase of all the excitation energies and in an increase in the nuclear magnetic shielding constants. (auth)

## Isotope Exchange and Isotope Separation

**27594** SPECIFIC ACID CATALYZED DEUTERATION OF THE ACETYL GROUPS OF 2,4-DIACETYLDEUTEROHEMIN-OMe. Oster, O.; Neireiter, G. W.; Gurd, F. R. N. (Indiana Univ., Bloomington (USA). Dept. of Chemistry). Z. Naturforsch., b; 30: No. 2, 288-289(Mar 1975).

The methyl group of the acetyl groups in 2,4-diacetyldeuterohemin-OMe was selectively deuterated. After removal of the iron, $D_4$-2,4-diacetyldeuteroporphyrin-OMe can be reduced to the corresponding hematoporphyrin and subsequent dehydration gives deuterated vinylic groups for protoporphyrin IX-OMe. (auth)

**27595** COMPLEX ION KINETICS. Reaction Rates on Ion-Exchange Resins Compared to Those in Water. Liss, I. B.; Murmann, R. K. (Univ. of Missouri, Columbia). Inorg. Chem.; 14: No. 10, 2314-2317(Oct 1975).

A comparison has been made between the rates in water and on an ion-exchange resin for the aquation $[(NH_3)_5CoOReO_3]^{2+}$ and $[(H_2O)_5CrCl]^{2+}$ and for the $^{18}O$ isotopic exchange of water with $[(NH_3)_5Co(OH_2)]^{3+}$ and $ReO_4^-$. The rate of water exchange on $[(NH_3)_5Co(OH_2)]^{3+}$ was not changed by association with Dowex 50W resins. Aquation of $[(NH_3)_5CoOReO_3]^{2+}$ and water exchange on $ReO_4^-$ had modified pH dependencies when associated with a resin. With the cobalt complex the rates were faster on the resin in the acidic region and slower on the resin in the basic region. A new term in the rate equation was observed when $ReO_4^-$ was on the resin, first order in $H^+$, while the other terms appear to be unchanged. Aquation of $[(H_2O)_5CrCl]^{2+}$ was much slower when it was absorbed on the resin. This was related to the known ionic strength effect of the reaction. (auth)

**27596** CONFORMATIONAL ANALYSIS OF THE THIOLANE RING SYSTEM. II. Proton Magnetic Resonance Spectra and Base-Catalyzed H–D Exchange of Sulfonium Cations and Sulfoxides Derived from 3,3-Dimethylthiolane and Trans-2-thiahydrindan. Barbarella, G.; Garbesi, A.; Fava, A. (CEA-CENG, Grenoble, France). J. Am. Chem. Soc.; 97: No. 20, 5883-5889(1 Oct 1975).

Proton NMR spectral analysis of 1,3,3-trimethylthiolanium iodide (III-$CH_3$) and 3,3-dimethylthiolane 1-oxide (III-O) allows the unambiguous configurational assignment of these five-membered S heterocycles. Both systems appear to be conformationally homogeneous; however, while the sulfonium cation adopts a half-chair conformation with maximum twist at $C_3$–$C_4$, the sulfoxide has an envelope conformation with sulfur at the tip and the oxygen functionality quasi-axial. In base-catalyzed H–D exchange of the alpha protons, the two compounds display quite different diastereotopic reactivity patterns, perhaps related to their different ground state conformation. Thus, the exchange is highly stereospecific in the sulfonium cation, but essentially nonstereospecific in the sulfoxide. By contrast, in the trans-2-thiahydrindan series where, by virtue of the trans ring fusion, the five-membered heterocycle is rigidly held in the half-chair conformation, the exchange is stereospecific in the sulfoxide as well, though less so than in the sulfonium cation. These results are examined together with those in the literature for comparable systems. However, there seems to be no obvious logical connection between kinetic acidity and geometrical factors. (auth)

**27597** MECHANISM OF CARBONIC ANHYDRASE STUDIED BY $^{13}C$ AND $^{18}O$ LABELING OF CARBON DIOXIDE. Tu, C. K.; Silverman, D. N. (Univ. of Florida, Gainesville). J. Am. Chem. Soc.; 97: No. 20, 5935-5936(1 Oct 1975).

The rapid rate of hydration of $CO_2$ catalyzed by carbonic anhydrase (EC 4.2.1.1) has previously been explained by the hypothesis that there is a proton transfer step in the mechanism involving the enzyme and buffers in solution. Supporting this explanation, a buffer dependence of the carbonic anhydrase-catalyzed exchange of oxygen-18 between bicarbonate and water at equilibrium and alkaline pH has been reported. Results are presented which further support this hypothesis by measuring the buffer dependence of the catalysis by bovine carbonic anhydrase of two types of $^{18}O$ exchange involving species of $CO_2$ and water. Type I: the $^{18}O$ exchange between bicarbonate and water was measured near neutral pH where the enzyme is most active. Type II: the exchange of $^{18}O$ between species of $CO_2$ in solution, measured as the exchange of $^{18}O$ between $^{12}C$- and $^{13}C$-containing molecules, was measured in the same pH region. (JGB)

**27598** LIMITS ON THE EFFECT OF PRESSURE ON ISOTOPIC FRACTIONATION. Clayton, R. N. (Chicago Univ.); Goldsmith, J. R.; Karel, K. J.; Mayeda, T. K.; Newton, R. C. Geochim. Cosmochim. Acta; 39: No. 8, 1197-1201(Aug 1975).

The equilibrium distribution of oxygen isotopes between calcium carbonate and water was determined at 500°C at pressures from 1 to 20 kbar and at 700°C at pressures of 0.5 and 1 kbar. At both temperatures, the pressure-dependence of the fractionation factor was below the limit of detection. The experimental results are consistent with theoretical estimates of the volume change due to isotope substitution. Application of the theory to silicate systems leads to the conclusion that pressure effects on oxygen isotopic fractionation between silicates are 0.2 ‰ at pressures of tens of kilobars. Thus the observed large variations of $^{18}O/^{16}O$ ratio in kimberlitic eclogites cannot be attributed to the effect of pressure. (auth)

# Radiation Chemistry

*Refer also to abstracts 27848, 28147, 28159, 28678, 28696, and 28732.*

**27599** (ANL-Trans-991) THEORETICAL AND EXPERIMENTAL STUDY OF ARGON LUMINESCENCE INDUCED BY ALPHA-PARTICLES. Henck, R.; Voltz, R. Translated from J. Phys. (Paris); 29: No. 2-3, 149-158(1968). 21p. Dep. NTIS $4.25.

An analysis of the nature and of the evolution of the atomic states excited in argon by fast ionizing particles leads to the conclusion that the radioluminescence of the gas at pressures of the order of one atmosphere is due to a radiative emission from excited dimers $A_2^*$. These dimers are formed in three-body collisions involving an atom $A^{**}$ excited in a state belonging to the configuration $(3p)^5$ 5s or $(3p)^5$ 3d. This is in agreement with the experimental results on the fluorescence spectra and decay times, obtained by methods which are briefly described. It is found that the mean lifetimes of the excited atom $A^{**}$ and dimer $A_2^*$ are respectively equal to $10^{-7}$ s and to $6 \times 10^{-9}$ s. The rate constant of the ternary collision producing the excited dimers is found to be $22 \times 10^{-32}$ $cm^6$ $s^{-1}$. The numerical values thus obtained are discussed. (auth)

**27600** (COO-958-52) PROPERTIES OF SOLVATED ELECTRONS AND ASSOCIATED SPECIES IN METAL SOLUTIONS AND KINETICS OF ELECTRON- AND PROTON-TRANSFER REACTIONS. Progress Report, 16 September 1974–15 September 1975. Dye, J. L. (Michigan State Univ., East Lansing (USA). Dept. of Chemistry). Sep 1975. Contract E(11-1)-958. 23p. Dep. NTIS $4.25.

The formation of salts of alkali metal anions has been shown to be a general phenomenon under suitable conditions. Solutions which contain $Na^-$, $Rb^-$ and $Cs^-$ have been identified by the use of alkali metal NMR techniques. Measurements of the rate of exchange of $M^+$ between crown and cryptate complexes and the solvated cation have been measured for $Li^+$, $Na^+$ and $Cs^+$. Preliminary measurements of the rate of alkali metal exchange between $NaC^+$ and $Na^-$ have been made with 18-Crown-6 as the complexing agent. The role of solvated electrons as intermediates has been examined. Studies of the properties of solid compounds which contain $M^-$ and/or $e^-$ have been continued. Gold-colored solids have been obtained for Na, K, Rb and Cs by solvent evaporation from a solution which contains the metal plus a complexing agent of either the crown or cryptand class. In the former case, solvent is present in the solid and is necessary for its stabilization. (auth)

**27601** (RI–8) ABOUT OZONIZATION OF THE IRRADIATED URANIUM SOLUTIONS. 1. Oxidation of Ru(4) by Ozone, Reduction of Ru(8) and Ru(7) in Alkaline Solutions. Shumkov, V. G.; Nikitina, G. P.; Ivanov, Yu. E.; Egorova, V. P.; Pushlenkov, M. F. (Radievyj Inst., Leningrad (USSR)). 1973. 40p. (In Russian). INIS.

Problems related to ozonization of nitric acid solutions of irradiated U and to absorption of the Ru(IV) formed in the process are considered. The kinetics of Ru(IV) oxidation by ozone and reduction of Ru(VIII) and Ru(VII) in sodium hydroxide solution are considered. Oxidation and reduction rate constants were determined. Probable mechanisms of these reactions are suggested. (tr-auth)

**27602** (RRL-3238-541) QUARTERLY REPORT, JULY 1, 1975–SEPTEMBER 30, 1975. (Mellon Inst. of Science, Pittsburgh (USA). Radiation Research Labs.). 8 Oct 1975. 17p. Carnegie-Mellon Univ.

Progress in the following studies is reported: hyperfine coupling constants of the NH protons in peptide radicals, one-electron reduction potentials of nitroaromatic compounds and ESR parameters of their radical anions, dehydrohalogenation of halophenols by OH, pulse radiolysis of chloride solutions, reaction of hydroxyl radicals with $K_3Cr(NCS)_6$, liquid chromatographic studies of the reactions of acetate radical, radiolytic denitration of nitroheterocyclic compounds, pulse radiolytic study of azodicarbonamide, and photochemically induced cis-trans isomerization: a liquid

chromatographic study. Abstracts of reports published during July 1, 1975 through September 30, 1975 are included. (LK)

**27603** SET-UP FOR PULSE RADIOLYSIS OF AGGRESSIVE SUBSTANCES. Kozlowska-Milner, E.; Broszkiewicz, R.; Stanikowski, J. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 22: No. 4, 269-273(25 Aug 1975).

A set-up for the pulse radiolysis of agressive substances with a relatively low consumption of the liquid, tested for anhydrous $HNO_3$, has been described. (auth)

**27604** MAGNETIC RESONANCE INVESTIGATION OF THE EFFECTS OF RADIATION ON AMINO ACIDS IN A GLASS MATRIX. Andrew, E. R.; Gale, H. J.; Hinshaw, W. S.; Vennart, W. (Nottingham Univ. (UK)). pp 271-272 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

Six amino acids, glycine, L-alanine, aspartic acid, cysteine, glutamic acid and serine, each dissolved in a neutral aqueous glass matrix, were irradiated with $^{60}Co$ γ-rays at 77°K, and examined by ESR to study the free radicals formed and their degradation with increasing temperature. The mobility of the molecules in the matrix was studied by proton NMR and the effect of the radicals formed on the proton relaxation rate. (auth)

**27605** EFFECT OF γ-RADIATION ON THE CATALYTIC ACTIVITY OF ZINC SULFIDE. Kalamazov, R. U.; Korshunova, G. D. (Inst. of Nuclear Physics, Tashkent). Kinet. Catal.; 16: No. 1, 106-109(1975).

Translated from Kinet. Katal.; 16: No. 1, 134-137(1975).

Consideration is given to the kinetic relationships for the decomposition of isopropanol in an adsorbed layer on ZnS under the action of heat and radiation. The rate and degree of decomposition have been found to depend on the conditioning temperature of the specimens and the initial vapor pressure of the alcohol. (auth)

**27606** RADIATION-INDUCED SYTHESIS OF HIGHER ALIPHATIC KETONES. Tarasova, N. P.; Zagorets, P. A.; Shostenko, A. G.; Dodonov, A. M.; Myshkin, V. E. (Moscow Inst. of Chemical Tech.). J. Gen. Chem. USSR; 45: No. 3, 675-677(Mar 1975).

Translated from Zh. Obshch. Khim.; 45: No. 3, 693-695(Mar 1975).

Higher aliphatic ketones were synthesized from lower ketones and olefins under the action of γ-radiation. The relation of the yield of reaction products to the proportions of the reactants taken was studied. (auth)

**27607** RADIATION CHEMISTRY OF CARBOHYDRATES. XVIII. Formation of Deoxy Sugars in the Radiolysis of Amino Sugars. Kudryashov, L. I.; Senchenkova, T. M. J. Gen. Chem. USSR; 45: No. 2, 426-427(Feb 1975).

Translated from Zh. Obshch. Khim.; 45: No. 2, 439-440(Feb 1975).

Investigation revealed a new type of transformation of amino sugars in irradiated aqueous solutions, leading to the formation of deoxy sugars containing the $CHOH-CH_2-CHO$ grouping. It was shown that the formation of the deoxy sugars goes with the participation of the hydrated electron. (auth)

**27608** GAMMA RAY INDUCED LOW TEMPERATURE IN SITU POLYMERIZATION OF VINYL CHLORIDE AND COPOLYMERIZATION OF VINYL CHLORIDE-VINYL ACETATE IN TAIWAN-PRODUCED WOODS. Wang, U. P. (Industrial Technology Research Inst., Hsinchu, Taiwan). J. Chin. Chem. Soc. (Taiwan); 22: No. 1, 77-89(Mar 1975).

Gamma-radiation-induced polymerization of vinyl chloride (VC) and copolymerization of vinyl chloride (VC)-vinyl acetate (VAc) in Taiwan cedars have been investigated at low temperatures. The polymerization-rate of VC and the copolymerization-rate of VC-VAc system in wood were found to be proportional to the n powers of the dose-rate, where n became close to the value of 1 as the polymerization temperature being lowered below 0°C. The oxygen in air was recognized to induce the delay of the induction period due to its retardation on the polymerization. The apparent activation energies of VC and VC-VAc for the polymerization and the copolymerization in wood were determined by use of the Arrhenius plotting as 4.0 Kcal/mole and 3.4 Kcal/mole respectively at the temperature-range of −15°C ~ 20°C. The degree of polymerization ($\bar{P}$) of VC was greatly affected by the polymerization temperature, although it was observed to be independent on the total gamma dose within 1 Mrad and the kinds of wood. No graft reaction of PVC polymer and PVC-PVAc copolymer onto the wood cellulose was found, while low graft percentage of about 3% being obtained at 20°C in the case of using swelling agents. However, this value was found to be decreased to 0.1% at the temperature of −15°C. Based on the above-mentioned experimental results, the radiation induced low temperature polymerization of VC or copolymerization of VC-VAc system in Taiwan produced cedars are considered to proceed with radical polymerization mechanism. (auth)

**27609** SPIN-SPIN INTERACTIONS OF TRAPPED RADICALS PRODUCED IN A 3-METHYLPENTANE BY GAMMA-IRRADIATION AT 77°K. Lin, D. P. (National Tsing Hua Univ., Hsinchu, Taiwan). J. Chin. Chem. Soc. (Taiwan); 22: No. 1, 7-15(Mar 1975).

EPR microwave power saturation technique has been applied to the systems of radiation-induced radicals in protiated and wholely deuterated 3-methylpentane to obtain the information concerning the high local spin concentration and radiation energy deposition mechanism. Evidences of spin-spin interactions have been given from the studies of isothermal decay of these trapped radicals at 77°K. The annealing of the matrix is shown to have almost no effect on the relaxation times of radicals. The influence of nuclear magnetic moment on the spin-lattice relaxation process of radicals is revealed and discussed on the basis of experimental results from the deuteration of the compound studied. (auth)

**27610** PROCESS FOR THE PRODUCTION OF MODIFIED TEXTILE MATERIALS. (to VEB Textilkombinat Cottbus). British Patent 1,392,371/B/. 30 Apr 1975. Filed Date 30 Jun 1972. 3p.

A process is described for the permanent texturing or structuring of textile materials consisting of two fibers behaving differently after subjection to ionizing radiation. The materials are subjected to electron irradiation at energies of the order of 0.3 to several MeV and are grafted with a monomeric compound. Examples of application of the process are given. (UK)

**27611** ELECTRON MOBILITIES AND RANGES IN LIQUID ETHERS: ION-LIKE AND CONDUCTION BAND MOBILITIES. Dodelet, J. P.; Freeman, G. R. (Alberta Univ., Edmonton). Can. J. Chem.; 53: No. 9, 1263-1274(May 1975).

The free-ion yields in x-irradiated ethers are larger than those in alkanes. The range of secondary electrons increases from the relatively low value for dimethyl ether to values for the higher ethers that are near to those of alkanes. At low temperatures, electrons migrate by an ionic mechanism, but at higher temperatures they move into a conduction band. (CA)

**27612** THEORETICAL MODEL OF ELECTRON SCAVENGING IN IRRADIATED GLASSY MEDIA BASED ON TUNNELLING MECHANISM. Dainton, F. S.; Pilling, M. J.; Rice, S. A. (Oxford Univ.). J. Chem. Soc. (London), Faraday Trans., II; No. 7, 1311-1321(1975).

A simple theory of electron tunnelling to scavenger sites in radiolyzed glasses is developed. A time-dependent radial density function of scavengers around central electrons is derived and used to construct a time-dependent rate constant [k(t)]. Values of k(t) for typical parameters are calculated by numerical integration. By approximating the radial density function to a rectangular step function, an analytical expression for the rate constant is obtained which agrees well with the exact results for times greater than $10^{-8}$s. An analytical expression for the dependence of the electron concentration on time and on scavenger concentration is also derived. These equations are tested using available experimental data, and sensible values are found for the depth of the electron trap in methyltetrahydrofuran and 6 mol $dm^{-3}$ NaOH glasses. Scavenging by $NO_3^-$ in 6 mol $dm^{-3}$ NaOH presents difficulties, which possibly arise from the anisotropy of the nitrate ion. (auth)

**27613** HOST EXCITATION OF LUMINESCENCE FROM KI:$Tl^+$ AND RbI:$Tl^+$ BY SLOW ELECTRON IMPACT. Huang, T.; Hamill, W. H. (Univ. of Notre Dame, IN). J. Chem. Phys.; 62: No. 7, 2849-2854(1 Apr 1975).

The luminescence of KI:$Tl^+$ and RbI:$Tl^+$ evaporated thin films in the range 30–300°K is excited by electron impact from approximately 4 to greater than or equal to 8 eV. Emission at 410 nm from KI:$Tl^+$ at 300°K was excited throughout the range 4.1–5.7 eV (the first optical exciton) and above. For 6.6 eV excitation at 70°K, the emission spectrum may contain unresolved contributions from the host at 376 and 410 nm as well as from the activator at 336 and 430 nm, the last being much the strongest. Optical absorption is known to excite intrinsic luminescence bands at 410, 376, and 300 nm. In RbI:$Tl^+$, the low-energy emission at 430 nm and 300°K was excited by electron impact throughout the range 4.0–5.7 eV (the first optical exciton) and above. The temperature dependence of the lifetime for the 430 nm bands of KI:$Tl^+$ agrees with results from the literature, while that of the intensity dependence agrees only in part.

Characteristic electron energy losses of the host lattice are unmodified by $Tl^+$ and the luminescence intensity is high, indicating host sensitization. (auth)

**27614** LUMINESCENCE OF NaOH, KBr : $OH^-$, AND KBr : $Tl^+$ UNDER SLOW ELECTRON IMPACT. Huang, T.; Hamill, W. H. (Univ. of Notre Dame, IN). J. Chem. Phys.; 62: No. 7, 2840-2848(1 Apr 1975).

Under low-energy electron impact the principal luminescence band of thin-film NaOH at 420 nm resembles that of KBr : $OH^-$ at 410 nm, both at approximately 300°K. The lowest energy luminescence excitation peaks occur at 4.5 and 6.5 eV for NaOH and at 4.9 and 6.0 eV for KBr : $OH^-$, all below the first optical excitons at 7.7 and 6.7 eV, respectively. The excitations of the 320 and 360 nm bands of KBr : $Tl^+$ are very similar to those of KBr : $OH^-$. Electron characteristic energy loss spectra for the three systems correlate with luminescence excitation spectra. Host sensitization of 3.0 eV emission of the $OH^-$ activator cannot involve the self-trapped exciton of KBr which emits at 2.3 eV. Neither can the emissions of thallium-doped KBr at 3.4 and 3.8 eV be so accounted for. Direct excitation of the activators by electron impact is very improbable and host sensitization is assumed. In doped KBr, unrelaxed excitons at approximately 4.9 eV may undergo cubic relaxation and diffuse by hopping to the activator site where they are trapped and emit (360 nm, KBr : $Tl^+$) or transfer (320 nm, KBr : $Tl^+$ and 420 nm, KBr : $OH^-$). (auth)

**27615** MODIFICATION OF RICE STARCH BY GAMMA IRRADIATION TO PRODUCE SOLUBLE STARCH OF LOW VISCOSITY FOR INDUSTRIAL PURPOSES. El Saadany, R. M. A.; El Saadany, F. M.; Foda, Y. H. (Ain Shams Univ., Cairo (Egypt). Dept. of Food Science). Staerke; 26: No. 12, 422-425(Dec 1974).

Because starch of low viscosity is important for industrial purposes this research was carried out to study the possibility of producing this sort of starch by treating rice starch with γ-irradiation. Results indicated that when rice starch was modified by γ-irradiation, the reducing power increased and degradation as well as molecular breakdown occurred followed by sharp decrease of its viscosity, specific viscosity, and intrinsic viscosity. Results showed that starch became more soluble on treatment with γ radiation and lost its resistance to water as its swelling capacity decreased. All these changes were proportional to the doses of γ-irradiation. (auth)

**27616** ANNEALING OF CHEMICAL RADIATION DAMAGE IN SODIUM CHLORATE. Das, B. K.; Mohanty, S. R. (Utkal Univ., Bhubaneswar, India). Indian J. Chem.; 13: No. 7, 718-720 (Jul 1975).

Thermal annealing of damage chlorite in γ-irradiated sodium chlorate is a combination of one first-order and two second-order reactions. (auth)

**27617** ELEKTRONNYE I IONNYE PROTSESSY V TVERDYKH TELAKH. VII. (Electron and Ion Processes in Solids. VII). Tbilisi, USSR; Izdatel'stvo Metsniereba Metsniereba (1974). 178p.

A series of articles are compiled on the radiation physics of ionic crystals, the physics of crystals with defects, and the mechanical properties of crystals are compiled. Separate abstracts were prepared for five of the articles. (JSR)

*For abstracts of individual chapters see: 27618–27620, 28696, and 29621.*

**27618** RADIATION-INDUCED CHANGES IN MICROSTRUCTURE AND LOW-TEMPERATURE HEAT CONDUCTIVITY OF IONIC CRYSTALS. Politov, N. G.; Kvachadze, V. G. pp 5-18 of Ekektronnye i Ionnye Protsessy v Tverdykh Telakh. VII. Tbilisi, USSR; Izdatel'stvo Metsniereba (1974). (In Russian)

Defects in LiF monocrystals resulting from neutron irradiation at different doses and temperatures were studied by measuring the thermal conductivities of the crystals before and after irradiation. A $10^{16}$ n/cm² irradiation at room temperature decreased the conductivity 20-fold and shifted the maximum toward higher temperatures. Irradiation at 110°K shifted the maximum still further toward higher temperatures. With a radiation dose of $10^{17}$ n/cm², the conductivity dropped by another two orders of magnitude. Decreasing the irradiation temperature slows down the aggregation process, while increasing the radiation dose by one order of magnitude increases the lattice parameter, especially at 110°K. (TTT)

**27619** KINETICS OF HYDROXYL REDUCTION IN GAMMA-IRRADIATED LiF CRYSTALS. Akhvlediani, Z. G.; Zlatov, B. N. pp 34-53 of Ekektronnye i Ionnye Protsessy v Tverdykh Telakh. VII. Tbilisi, USSR; Izdatel'stvo Metsniereba (1974). (In Russian)

Hydroxyl reduction in gamma-irradiated LiF crystals was slower in air than in a vacuum, probably because of convection in air layers on the open ampule in which the annealing took place. Complete reduction in vacuum indicates that the hydroxyl decomposition products remain in the lattice of the irradiated LiF. The infrared and electron spectra of the gamma-irradiated crystals do not show what mechanism takes place in the hydroxyl destruction, and the intermediate and final products of the process have not been identified. Annealing data for temperatures from 150 to 600°K are presented graphically. (TTT)

**27620** RADIATION DEFORMATION IN THIN LiF CRYSTALS. Metreveli, P. I.; Natsvlishvili, G. I. pp 109-119 of Ekektronnye i Ionnye Protsessy v Tverdykh Telakh. VII. Tbilisi, USSR; Izdatel'stvo Metsniereba (1974). (In Russian)

Thin LiF films, irradiated to $10^4$-$10^{18}$ n/cm² in a reactor were studied in an electron microscope. With long electron bombardment, as the absorbed radiation dose increased multi-ended figures were seen in different parts of the surface. Heating of the film surface causes transfer of amorphous material to irregularities of the surfaces or edges of the film. Within the film the electron beam causes formation of crater-vacancies. The effect of large neutron doses ($10^{17}$-$10^{18}$) causes formation on the surface of the thin film of layers consisting of a large number of chaotically oriented crystals, some of which are as large as 3000 Å. The data indicate that under the monocrystal layer is a polycrystalline substrate. The newly formed layer apparently is made up of material drawn from the matrix and brought out to the surface as a result of action of the neutron beam. (TTT)

**27621** DETECTION OF CORN STARCH IRRADIATED WITH LOW DOSES OF GAMMA RAYS. III. Positive Identification of Malonaldehyde in Irradiated Starch by Isolation and Characterization as the Thiobarbituric Acid Derivative. Stewart, A. B.; Winchester, R. V. (National Nuclear Research Centre, Pretoria (South Africa). Chemistry Div.). Staerke; 27: No. 1, 9-11(Jan 1975).

Malonaldehyde, not previously identified unequivocally, has been characterized as a radiolysis product of starch. The elemental composition, ir and nmr spectra of the thiobarbituric derivative are identical to those of the same derivative made from authentic malonaldehyde. (auth)

**27622** PULSE RADIOLYSIS OF GASES: OPTICAL SPECTRUM AND REACTIONS OF $N_4^+$ (OR $N_3^+$) AT ATMOSPHERIC PRESSURE. Dreyer, J. W.; Perner, D.; Roy, C.; Volz, A. (Kernforschungsanlage Juelich G. m. b. H. (F. R. Germany). Inst. fuer Physikalische Chemie). Ber. Bunsenges. Phys. Chem.; 79: No. 3, 270-277(Feb 1975). (In German).

An ion $N_x^+$ is formed by the reactions of positive ions with nitrogen. The optical absorption spectrum of this ion has a maximum at 365 nm with no evidence of fine structure. It is possibly a dissociation spectrum with an origin above 600 nm and is attributed to either $N_4^+$ or $N_3^+$. Most arguments, however, tend to favour $N_4^+$. The $N_x^+$ disappears in pure nitrogen through neutralization by electrons. The presence of other simple gases accelerates the rate of disappearance and rate constants for $N_x^+$ reactions with these additives are determined. (auth)

**27623** STRUCTURE AND RECOMBINATION OF RADICALS IN AMINO ACID CRYSTALS. Joshi, A. M. Tallahassee, FL; Florida State University (1975). 156p. University Microfilms Order No. 75-15,499.

Thesis (Ph. D.).

Decay kinetics, of the free radicals produced in crystalline amino acids by x-irradiation, was studied in the temperature range 25° to 185°C. The decay data could not be fitted to a first order rate law. Second order plots indicated two distinct second order processes: the initial faster process and the major slightly slower process. The initial process was of short duration at higher temperatures and at all temperatures it was responsible for the decay of 25 to 30 percent of the initial number of radicals. A vacancy controlled bulk diffusion mechanism is proposed for the major process and the initial process is postulated to be a conformationally favoured bulk diffusion process. L-Arginine HCl monohydrate on x-irradiation at room temperature shows radicals that are stable (relatively) at room temperature but decay at temperatures above 40°C. The decay at 75°C is found to be zero order while the crystal dehydrates simultaneously. A hydrogen abstraction mechanism is proposed for the spin decay on the basis of the crystal structure and the radical structure. The radical structure was determined from the angular studies of the single crystals. (Diss. Abstr. Int., B)

**27624** RADIOLYSIS STUDIES OF BINARY MIXTURES CONTAINING PYRIDINE. Fletcher, G. Kensington, Australia; University of New South Wales (1974). vp. Librarian, Univ. of New South Wales, Kensington, Australia.

Thesis (Ph. D.).

The effects of pyridine on the formation of radiolysis products from methanol in methanol–pyridine mixtures and cyclohexane in cyclohexane–pyridine mixtures were studied. Initially, chemical participation of pyridine during radiolysis is probed by efforts to detect, identify, and measure yields of products unique to mixtures. Subsequently isotope effects and the effect of dose, $N_2O$, and acid on product yields from methanol–pyridine and cyclohexane–pyridine mixtures are reported, and implications concerning product formation as well as the affinity of pyridine for the various solvent reactive species are discussed. (JGB)

**27625** TEMPERATURE DEPENDENCE OF THE HFI CONSTANT FOR THE >CH FRAGMENT IN RADICALS OF THE TYPE $HOOCCH_2C(CH_3)_2CHCOOH$. Dikanov, S. A.; Yudanov, V. F.; Tsvetkov, Yu. D. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). J. Struct. Chem.; 16: No. 1, 118-119(1975). Translated from Zh. Struk. Khim.; 16: No. 1, 134-136(1975).

The $\gamma$-irradiation of monocrystals of 3,3-dimethylglutaric acid (I), obtained by slow evaporation from aqueous solution, was studied. Irradiation was effected with $^{60}Co$ $\gamma$ rays at room temperature (dose ~ 1.5 Mrad). It is known [1] that radicals of the type $HOOCCH_2\dot{C}(CH_3)_2CHCOOH$ are formed in monocrystals of (I) when they are irradiated. In these radicals, the hyperfine structure of the ESR spectrum is due to the interaction of the unpaired electron with the $\alpha$ proton. By analyzing the angular dependence of the splitting $\Delta H$ in the ESR spectrum at room temperature, it was possible to determine the principal values of the HFI tensor, which are $^{-}27.8$, $^{-}65.5$, and $^{-}85.7$ MHz, and the isotropic constant $\alpha$(300°K), which is 60 MHz for the $\alpha$ proton. On lowering the temperature from room temperature to 77°K, reversible changes were found in the ESR spectrum. At the low temperature, each of the components of the doublet is additionally split into two lines. Analysis of the angular dependence of the splittings in the spectrum at 77°K showed that, within the limits of experimental error, the additional splitting $\Delta H_2$ is isotropic and equal to 22.4 MHz at 77°K. With increasing temperature, the $\Delta H_2$ splitting first diminishes and then the components of the additional doublet completely coalesce. On the basis of experiments with monocrystals of (I) in which the protons of the hydroxyl groups were replaced by deuterium, it was established that the additional splitting $\Delta H_2$ is not connected with the hydroxylic protons. (auth)

**27626** EXPERIMENTAL INSTALLATION FOR THE INVESTIGATION OF RADIOLYSIS IN LIQUID, LIQUID-GAS, AND GASEOUS MEDIA. Korolev, V. M.; Khomich, F. G.; Makarevich, L. A. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 56-58(1975). (In Russian).

An installation is described for rapid and effective radiation-induced reactions gaseous and liquid mediums such as radiation oxidation, amination, carboxylation, and oximethylation. (auth)

**27627** PROCESS OF RADIATION-INDUCED POLYMERIZATION OF STYRENE ON FIBERS IN THE PRESENCE OF AN OXIDIZING AGENT. Kapustina, I. B.; Kurilenko, A. I. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 51-55(1975). (In Russian).

Radiation-induced polymerization of styrene on fibers in the presence of methanol was studied. The rate of styrene homo- and graft-polymerization differs and depends on many factors. The probable mechanism of formation of homopolystyrene on the different fibers was proposed. (auth)

**27628** EFFECT OF $N_2O_4$ MEDIUM AND $\gamma$ RADIATION ON THE PROPERTIES OF FLUORINATED LUBRICANTS. Sukhotin, A. M.; Semerikov, I. A.; Rossomakho, G. A. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 47-50(1975). (In Russian).

The chemical stability of a number of fluorinated lubricating oils in nitrogen tetroxide is studied. Test lubricating oils and lubricants are compatible and resistant in nitrogen tetroxide. Nitrogen tetroxide is soluble in fluoro-organic liquids but chemically does not react with it. Radiation resistance of a number of fluorinated oils and lubricants is studied. It is shown that the dose of $10^8$ rad does not lead to a change of physical-chemical properties of liquids and lubricants. Corrosion activity of the liquid 4 LF under irradiation slightly increases. (auth)

**27629** PROPERTIES OF POLYETHYLENE FILMS MODIFIED BY THE RADIOCHEMICAL METHOD. Il'in, S. N.; Shaposhnikova, T. K.; Yemel'yanova, T. A.; Margolin, D. M.; Terekhov, V. D. Plast. Massy; No. 1, 16-18(1975). (In Russian).

The possibility of increasing the elastic properties of low-density polyethylene by radiation modification is being analyzed. The irradiation conditions are described as well as basic properties of the irradiated material. Using proton and accelerated electron irradiation improved the elasticity of polyethylene samples. (JPRS)

**27630** RADIOLYSIS OF 0.4 M SULFURIC ACID SOLUTIONS WITH FISSION FRAGMENTS FROM DISSOLVED CALIFORNIUM-252. Estimated Yields of Radical and Molecular Products That Escape Reactions in Fission Fragment Tracks. Bibler, N. E. (E. I. du Pont de Nemours and Co., Aiken, SC). J. Phys. Chem.; 79: No. 19, 1991-1995(11 Sep 1975).

Radiolysis of 0.4 M sulfuric acid solutions at very high linear energy transfer (LET) values (approximately 400 eV/A) was studied with fission fragments from dissolved $^{252}Cf$. This isotope irradiates the solution with both fission fragments and alpha particles. Visible and uv absorption spectroscopy were used to determine $G(Fe^{3+})$ in $10^{-3}$ M $Fe^{2+}$, $G(Ce^{3+})$ in $10^{-4}$ M $Ce^{4+}$-$10^{-3}$ M $Ce^{3+}$, and $G(Ce^{3+})$ in $10^{-4}$ M $Ce^{4+}$-$10^{-3}$ M $Ce^{3+}$ containing $10^{-3}$ M (and $10^{-2}$ M) $Tl^+$. Values for $G(H_2)$ were determined manometrically. Experiments with alpha particles (LET approximately 9 eV/A) from dissolved $^{244}Cm$ verified the technique and measured 100 eV yields (G values) for pure alpha radiolysis. Experiments with mixtures of $^{244}Cm$ and $^{252}Cf$ established that the effects of fission fragments and alpha particles are independent. The following results were obtained for $G(Fe^{3+})$, $G(Ce^{3+})$, $G(Ce^{3+})$ in 0.001 M $Tl^+$, and $G(H_2)$, respectively: for $^{244}Cm$ 5.1, 2.9, 3.3, 1.3; for $^{252}Cf$ 4.4, 2.7, 2.9, 1.8; for fission fragments 3.3, 2.4, 2.4, 2.1. Interpretation of the fission fragment yields leads to the following estimates for the respective species escaping track reactions: $G(H_2)$ equals 2.1, $G(H_2O_2)$ equals 0.96, $G(HO_2)$ equals 0.5, G(OH) equals 0, and G(H) equals 0. (auth)

**27631** PHYSICAL PROPERTIES OF POLY(OCTADECYL METHACRYLATE) PRODUCED BY RADIATION-INITIATED POLYMERIZATION. Chow, B. L. Raleigh, NC; North Carolina State Univ. (1974). 120p. University Microfilms Order No. 75-5350.

Thesis (Ph. D.).

The structure and physical properties of poly(octadecyl methacrylate) produced by radiation-initiated polymerization carried out in the solid and liquid states of the monomer at 0 and 42°C, respectively, were studied. Both melting point and calculated heat of fusion of the polymer produced by polymerization in the solid state were much higher than those of the polymer prepared in the liquid state. In the radiation-induced emulsion polymerization of octadecyl methacrylate, it was found that the percent yield of polymer depended on the total amount of exposure to radiation and temperature at which the polymerization was carried out. The yield of polymer increased with both temperature and radiation dose. (LK)

**27632** THEORETICAL RELAXATION RATES OF DIPOLE ORIENTATION AROUND AN EXCESS ELECTRON IN LIQUID ALCOHOLS. Fueki, K.; Feng, D. F.; Kevan, L. (Wayne State Univ., Detroit). pp 104-108 of Fast Processes in Radiation Chemistry and Biology. Adams, G. E. (ed.). New York; John Wiley, Inc. (1975).

A method was developed for calculation of relaxation times for dipole orientation in liquid alcohols induced by localized excess electrons. A microscopic model is used which utilizes quantities calculated from the Fueki, Feng, Kevan semicontinuum model of solvated electron energy levels. Given the semicontinuum model results, the relaxation times are calculated as functions of temperature with no adjustable parameters. Calculated results for methanol, ethanol and 1-propanol agree well with the limited experimental data available from Hunt, Baxendale and Wardman, and Thomas and Beck. The calculated results agree best for propanol and imply that the theoretical model is most applicable to larger molecule solvents. The impressive agreement between experiment and theory suggest that simple orientation is the mechanism of rapid electron solvation in polar liquids. (auth)

**27633** THE ESR SPECTRUM AND STRUCTURE OF THE DIMER RADICAL CATION OF DIMETHYL SELENIDE ($Me_2Se$-$SeMe_2^+$) IN A $\gamma$-IRRADIATED SINGLE CRYSTAL. Nishikida, K.; Williams, F. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry). Chem. Phys. Lett.; 34: No. 2, 302-306(15 Jul 1975).

The dimer radical cation of dimethyl selenide was identified in a $\gamma$-irradiated single crystal of the parent compound, its main ($^{even}Se$) ESR spectrum showing hyperfine coupling to twelve equivalent hydrogens. Also, the relative intensity of the naturally abundant $^{77}Se$ satellite spectrum is in agreement with a hyperfine interaction involving two anisotropically equivalent selenium atoms. The principal values and direction cosines of the $^{77}Se$ hyperfine and g tensors were determined and were found to be satisfactorily interpreted in terms of a centrosymmetric structure, the unpaired electron occupying an antibonding ($\sigma^*$) orbital built almost entirely from the $P_0$ orbitals of the two selenium atoms. Analysis of the g tensor components indicates that the CSeC planes are perpendicular to the direction of the Se-Se bond. It is also shown that the isotropic $^1H$ splitting and g factor obtained previously from solution ESR studies of the dimethyl sul-

fide dimer cation are consistent with the structure advanced here for the selenium dimer. The results seem to rule out the possibility of any significant d orbital participation in the bonding. (auth)

# Radiochemistry and Nuclear Chemistry

*Refer also to abstract 27590.*

## Hot-Atom Chemistry

**27634** (COO-1713-60) REACTION STUDIES OF HOT SILICON AND GERMANIUM RADICALS. Progress report, 1 September 1974–29 August 1975. Gaspar, P. P. (Washington Univ., St. Louis, Mo. (USA). Dept. of Chemistry). 29 Aug 1975. Contract E(11-1)-1713. 21p. Dep. NTIS $4.25.

Progress was made in the following major areas: primary steps in the reactions of recoiling silicon and germanium atoms; the role of ionic reactions in the chemistry of recoiling silicon atoms; other ion-molecule reaction studies; silylene reaction studies; thermal evaporation of germanium atoms; study of silyl radicals by electron spin resonance spectroscopy; and study of abstraction of moieties other than hydrogen by recoiling silicon atoms. (auth)

**27635** REACTIONS OF RECOIL $^{13}N$ ATOMS WITH SOME ORGANIC COMPOUNDS IN THE SOLID AND LIQUID PHASES. Welch, M. J.; Straatmann, M. G. (Washington Univ., St. Louis, Mo. (USA). Edward Mallinckrodt Inst. of Radiology). Radiochim. Acta; 20: No. 3, 124-129(1973).

The reactions of $^{13}N$ with acetic acid (solid and liquid phases), acetaldehyde, and ethanol were studied. In all these systems the major products observed were $^{13}NH_3$, $C^{13}N^-$, and $^{13}NO_3^-$, with $CH_3{}^{13}NH_2$, $CH_3C^{13}N$, $CH_3CO^{13}NH_2$, and $^{13}NO_2^-$ also being characterized in some cases. The variation in ammonia yield with carbon skeleton was studied to help elucidate the mechanism of ammonia formation. Only in the formation of $CH_3C^{13}N$ (3.5%) from acetaldehyde and $CH_3CO^{13}NH_4$ (24%) from ethanol were measurable quantities of products due to non-degradative incorporation of nitrogen observed. With water–ethanol mixtures the acetamide yield, however, increases to > 50%. This could be accounted for by deactivation of an excited nitrogen atom by the water to a low state which has a greater reactivity with organic compounds than with water. (auth)

**27636** REACTIONS OF RECOIL TRITIUM ATOMS WITH THE SYSTEM, ETHYLENE, AND OXYGEN. Johnston, A. J. (North East London Polytechnic, Dagenham (UK). Chemistry Dept.); Urch, D. S. (Queen Mary Coll., London (UK). Dept. of Chemistry). Radiochim. Acta; 20: No. 3, 120-123(1973).

The yields of tritium-labelled products derived from the reactions of recoil tritium atoms with the system ethylene–oxygen, are amenable to conventional Estrup–Wolfgang analyses if oxygen is regarded as a moderator. HT and $C_2H_3T$ appear to be formed by hot atoms of roughly the same mean energy. The results are compared with those for the helium moderation of ethylene, and it is found that oxygen is a slightly better moderator for hot tritium atoms than helium. It is proposed that the labelled acetylene that is observed arises from the unimolecular decomposition of a tritiated ethylene molecule, vibrationally excited as a result of the labelling reaction. (auth)

**27637** CHEMICAL STATE OF RECOIL MANGANESE IN SOLIDS MANGANOUS SALTS. Owens, C. W.; Lecington, W. C. (Univ. of New Hampshire, Durham). Inorg. Nucl. Chem. Lett.; 11: No. 10, 673-675(Oct 1975).

The chemical state of recoil $^{56}Mn$ produced by the $^{55}Mn(n,\gamma)^{56}Mn$ transformation in solid $Mn(C10_4)_2 \cdot 6H_2O$, $Mn_3(PO_4)_2 \cdot 7H_2O$, $MnSO_4 \cdot H_2O$, $MnCO_3$, and $MnCl_2 \cdot 4H_2O$ was determined. It was found that more than 99% of the $^{56}Mn$ radioactivity appeared in the cationic fraction. (auth)

**27638** SPECTRAL DETECTION OF CARBONYL COMPOUNDS OF THE LANTHANOIDS AND ACTINOIDS. Sheline, R. K. (Florida State Univ., Tallahassee (USA). Dept. of Chemistry); Slater, J. L. (Virginia Univ., Charlottesville (USA). Dept. of Chemistry). Angew. Chem.; 87: No. 9, 332-337 (May 1975). (In German).

Co-condensation of lanthanide or actinide atoms and a mixture of much argon and little carbon monoxide on a surface cooled with liquid helium, after annealing of the thus formed matrix, leads to a series of new binary lanthanide or actinide carbonyl compounds. A first evaluation of the IR spectra indicates that for each metal, at least six complexes $M(CO)_{1-6}$ are observed. The ytterbium derivatives show clearly deviating spectra probably due to the fact that one electron is missing in ytterbium to give the full 4f shell. (auth)

**27639** THE REACTIONS OF ATOMIC HYDROGEN WITH CYCLOHEXENE, CYCLOHEXADIENE-1,3, AND BENZENE. Hoyermann, K.; Preuss, A. W.; Wagner, H. G. (Goettingen Univ. (F. R. Germany). Inst. fuer Physikalische Chemie). Ber. Bunsenges. Phys. Chem.; 79: No. 2, 156-165(Feb 1975). (In German).

The reactions of hydrogen atoms with cyclic $C_6$-hydrocarbons (cyclohexene, cyclohexadiene-1,3, benzene) were studied in the temperature range $296 <= T <= 493$ K, in the pressure range $1.9 <= p <= 14.7$ Torr and at high $[hc]_0/[H]_0$ ratios in an isothermal flow reactor, using ESR, mass spectrometry, and gas-chromatography detection techniques. The rate constants were evaluated to be: $H + C_6H_{10} \rightarrow C_6H_{11}^{\cdot}$; $K = (3.2 \pm 0.4) \times 10^{13} \exp(-10.5 \pm 2.5$ kJ/mol : RT) $cm^3$/mol sec; $H + C_6H_6 \rightarrow C_6H_7^{\cdot}$; $k = (3.2 \pm 0.4) \times 10^{13} \exp(-6.3 \pm 1.3$ kJ/mol : RT) $cm^3$/mol sec; $H + C_6H_6 \rightarrow C_6H_7^{\cdot}$; $k = (6.9 \pm 1.5) \times 10^{12} \exp(-15.5 \pm 2.9$ kJ mol : RT) $cm^3$/mol sec. At higher pressures ($p > 5$ Torr) and high excess of hydrocarbon, ring cleavage in subsequent reactions was found to be of minor influence. The major products of reaction were as follows: for cyclohexene, cyclohexane, for cyclohexadiene-1.3, cyclohexene and cyclohexane, for benzene, cyclohexene, cyclohexadienes, and cyclohexane. (auth)

**27640** HOT DISPLACEMENT REACTIONS OF $^{38}Cl$ WITH $CH_3Br$ AND $^{80}Br$ WITH $CH_3Cl$ IN THE GAS PHASE. Evidence For a Possible Billiard Ball Mechanism. Alfassi, Z. B.; Amiel, S. (Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Nuclear Sciences; Israel Atomic Energy Commission, Yavne. Nuclear Chemistry Dept.). Radiochim. Acta; 20: No. 3, 130-134 (1973).

Yields of various products of the reactions of hot $^{38}Cl$ with $CH_3Br$ and hot $^{80}Br$ with $CH_3Cl$ were measured for different concentrations of noble gas moderator (He for the first reaction and Ne for the second). The reactivity integrals and the average logarithmic energy losses of the hot atoms colliding with the reactant molecules were calculated. Average logarithmic energy decrements values equal to 5.6 $\alpha$ (for Cl-He) and 3.2 $\alpha$ (for Br-Ne) respectively, and the reactivity integrals equal to 0.24 $\alpha$ (for Cl-He) and 0.097 $\alpha$ (for Br-Ne) respectively were derived. Comparison of the above reaction with each other and with the reactions of $^{38}Cl$-$CH_3Cl$ and $^{80}Br$ with $CH_3Br$ suggests that a billiard ball mechanism may be responsible to a considerable extent for all four reactions. (GE)

**27641** REACTIONS OF ATOMIC HYDROGEN WITH KETENE AND ACETALDEHYDE. Slemr, F.; Warneck, P. (Max-Planck-Institut fuer Chemie (Otto-Hahn-Institut), Mainz (F. R. Germany)). Ber. Bunsenges. Phys. Chem.; 79: No. 2, 152-156(Feb 1975).

The reaction of hydrogen atoms or deuterium atoms with ketene yields predominantly $CH_3$ radicals and CO. The associated rate coefficient can be expressed by $k_2 = (6.0 \pm 2.2) \times 10^{-12} \exp[-(2,340 \pm 200)$cal/mol $\times$ RT]$cm^3$/molecule $\times$ sec. Acetyl radicals resulting from the reaction of hydrogen atoms with acetaldehyde react with H atoms to produce ketene and molecular hydrogen with 63 percent yield; a second reaction channel produces $CH_3$ and HCO radicals with 37 percent yield. (GE)

**27642** HOT HYDROGEN ATOMS REACTIONS OF INTEREST IN MOLECULAR EVOLUTION AND INTERSTELLAR CHEMISTRY. Becker, R. S.; Hong, K.; Hong, J. H. (Houston Univ., Tex. (USA). Dept. of Chemistry). J. Mol. Evol.; 4: No. 2, 157-172(1974).

1 fig.; 2 tabs.; 20 refs.

Hot hydrogen atoms, which are photochemically generated, initiate reactions among mixtures of methane, ethane, water and ammonia, to produce ethanol, organic amines, organic acids, and amino acids. Both ethanol and ethyl amine can also act as substrates for formation of amino acids. The one carbon substrate methane is sufficient as a carbon source to produce amino acids. Typical quantum yields for formation of amino acids are approximately 2 to $4 \times 10^{-5}$. In one experiment, 6 protein amino acids were identified and 8 non-protein amino acids verified utilizing gas chromatography-mass spectroscopy. (auth)

## Properties of Radioactive Materials

*Refer also to abstracts 27601, 27921, 28328, 28415, and 28460.*

**27643** (AERE-M-2189) SCANNING ELECTRON MICROSCOPY OF RADIOACTIVE SAMPLES: THE INFLUENCE OF ACTIVITY LEVEL ON PICTURE QUALITY. Jackson, C. K.; Poole, D. M. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Oct 1969. 13p. Dep. NTIS (US Sales Only) $4.00.

The degradation of scanning electron microscope pictures

due to noise resulting from the presence of $\beta\gamma$ active samples was investigated. The picture quality obtained in a Cambridge Instrument Co. "Steroscan" is only slightly reduced when a source giving a dose rate of 2,500 mR/hr $\beta\gamma$ at 1 foot is close to the specimen position; operation at somewhat higher beam currents than normal is the only change necessary for samples up to this activity level. (auth)

**27644** (BNWL-SA-5514) Harmon, K. M. PNL STUDIES OF D AND D AT HANFORD. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract AT(45-1)-1830. 20p. (CONF-750822-8). Dep. NTIS $4.00.

From conference on decontamination and decommissioning of ERDA facilities; Idaho Falls, Idaho, USA (19 Aug 1975).

The PNL decontamination and decommissioning program at Hanford involves (1) the preparation of a long-term plan for a systematic approach to the extensive and varied programs of decommissioning retired facilities at Hanford and (2) a D and D demonstration project, the decommissioning of a grossly contaminated plutonium processing facility. (auth)

**27645** (CNEA-385) INFLUENCE OF ZIRCONIUM ON THE LABELLING STABILITY OF ALBUMIN MACROAGGREGATES WITH INDIUM-113m. Caro, R. A.; Ciscato, V. A.; Ihlo, J. E.; Nicolini, J. O.; Palcos, M. C.; Radicella, R. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1975. 20p. (In Spanish). Dep. NTIS (US Sales Only) $4.00.

Physicochemical and biological studies are described to standardize the preparation of $^{113m}$In-labeled albumin macroaggregates (MAA), for its utilization as a tracer in lung scintiscanning. The presence of 20 $\mu$g of Zr(IV) and 4 mg of $Na_2HPO_4$ per milliliter of suspension is necessary in order to fix the $^{113m}$In to the MAA and to minimize its separation "in vivo" owing to the presence of plasma transferrin. (auth)

**27646** (CNEA-386) PREPARATION OF ANGIOTENSIN I $^{125}$I; DETERMINATION OF RENIN PLASMATIC ACTIVITY BY RADIOIMMUNOASSAY. Hauger-Klevene, J. H.; Quihillalt, E. L.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1975. 20p. (In Spanish). Dep. NTIS (US Sales Only) $4.00.

The preparation (150-200 mCi/mg) Angiotensin I $^{125}$I is described, as well as its use in the measurement of plasma renin levels by radioimmunoassay in a variety of clinical situations. (auth)

**27647** (CNEA-387) PREPARATION OF ACTH $^{125}$I OR $^{131}$I; ITS USE IN RADIOIMMUNOASSAY. Bruno, O. D.; Quihillalt, E. L.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1975. 13p. (In Spanish). Dep. NTIS (US Sales Only) $4.00.

The preparation of adrenocorticotropin hormone (ACTH) labelled with $^{125}$I and $^{131}$I is described. Test for the determination of the immunoreactive behavior of the hormone is accomplished. (auth)

**27648** (CNEA-388) PREPARATION OF MERCURASCAN $^{131}$I. Bianco de Salas, G. N.; Correia, R. J.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1975. 8p. (In Spanish). Dep. NTIS (US Sales Only) $4.00.

A method for labelling Mercurascan with $^{131}$I is described, using chloramine T as oxidizing agent and incandescent lamp as photochemical catalyst. A radiochemical yield of 100% is achieved. The radiochemical purity is controlled by paper and thin-layer chromatography. (auth)

**27649** (CNEA-389) PHYSICO-CHEMICAL ASPECTS OF THE BOVINE GROWTH HORMONE IODINATION BY THE ELECTROLYTIC METHOD. Caro, R. A.; Ciscato, V. A.; de Giacomini, S. M. V.; Kurcbart, H.; Quiroga, S.; Radicella, R. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1975. 17p. (In Spanish). Dep. NTIS (US Sales Only) $4.00.

The mechanism of iodination of Bovine Growth Hormone (BGH) was studied by means of the electrolytic method, at pH 7.4, with a current intensity of 20 $\mu$A, as a function of time and for different total iodide to protein ratios. The yield of each labeling process was determined by paper electrophoresis. From these values and from the amount of protein present in the reaction, the iodination degrees were calculated; frequently, iodination degrees higher than 12 (the maximum theoretically possible), were obtained. When the enzymatic hydrolysis of the samples was carried out, an increase of free iodide was observed, which was more significant at high iodide to protein molar ratios. The quantitative analysis of the chromatograms of the hydrolyzed samples allowed us to determine the relative amount of monoiodotyrosine (MIT) and diiodotyrosine (DIT) for different iodination degrees. It could be shown that for an iodination degree of 12, only 70 per cent of the radioactivity appeared as DIT. The calculation of the relative iodination degree for each iodide to protein molar ratio from the results of the hydrolysis, demonstrated that only 75 per cent of the total available tyrosine residues admits the incorporation of iodine. Thus, it can be deduced that not all the tyrosine residues are equally accessible for the iodine atom. (auth)

**27650** (CNEA-390) PHYSICO-CHEMICAL STUDIES ON A NEW PRODUCTION METHOD OF RADIOACTIVE GOLD COLLOIDS. Barrabin, H.; Caro, R. A.; Ihlo, J. E.; Radicella, R.; Richards, D. E. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1975. 13p. (In Spanish). Dep. NTIS (US Sales Only) $4.00.

The preparation of gelatin protected radiogold colloids with small particles is described. A simplified procedure is utilized by which it is possible to eliminate the complicated equipment used until now. Some of the physicochemical parameters which affect the process are also analyzed. (auth)

**27651** (JINR-R-12-7767) PREDICTION OF SUPERHEAVY ELEMENTS AND THEIR CHLORIDES BEHAVIOUR DURING THERMOCHROMATOGRAPHIC SEPARATION. Ajkhler, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1974. 21p. (In Russian). INIS.

By extrapolation of thermodynamic data, the most probable chemical properties of the super-heavy elements were determined by evaporation of them in a current of hydrogen or chlorine. Standard heats of sublimation of these elements and their chlorides were evaluated. The results obtained are discussed from the point of view of the possibility of thermochromatographic separation of the products of nuclear reactions. The possibility of selective separation of elements with Z = 112-117 in a current of hydrogen is shown. (tr-auth)

**27652** (JINR-R-12-7775) THERMOCHROMATOGRAPHY OF NUCLEAR REACTION PRODUCTS WITHOUT CARRIERS IN THE FORM CHLORIDES. Ajkhler, B.; Domanov, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1974. 22p. (In Russian). INIS.

The temperatures of precipitation of the chlorides of 47 elements from a carrier-free gas current were determined in a thermochromatographic column filled with quartz powder. A correlation was observed between the precipitation temperatures and the standard heat of sublimation of the chlorides. From thermochromatographic data conclusions were made concerning their chemical state of some elements under the conditions of the experiment, which cannot be confidently predicted a priori. By extrapolation of data on the standard heats of sublimation of chlorides of the hypothetical elements 112-115, the probable temperature intervals at which they will be precipitated were predicted. (tr-auth)

**27653** (LBL-4076) MAGNETIC SUSCEPTIBILITY OF $^{244}$Cm METAL AND $^{249}$Cf METAL. Fujita, D. K.; Parsons, T. C.; Edelstein, N.; Noe, M.; Peterson, J. R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7404-eng-48. 9p. (CONF-750913-12). Dep. NTIS $4.00.

From 4th international transplutonium elements symposium; Baden-Baden, F. R. Germany (13 Sep 1975).

The first magnetic susceptibility measurements made on the expanded fcc phase of $^{249}$Cf metal are reported. Further measurements are needed on other Cf metal phases. Another measurement of the magnetic susceptibility of $^{244}$Cm metal in a limited temperature range has been reported. The result does not agree with previously reported values. Further work is continuing on the synthesis of $^{244}$Cm metal and $^{248}$Cm metal and magnetic measurements on these samples. (auth)

**27654** (NIIAR-P-226) X-RAY DIFFRACTION OF NEPTUNIUM(5), PLUTONIUM(5) AMERICIUM(5) MONOCARBONATES WITH ALKALINE METALS. Volkov, Yu. F.; Kapshukov, I. I.; Visyashcheva, G. I.; Osipov, S. V.; Yakovlev, G. N. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1974. 14p. (In Russian). INIS.

Carbonate compounds of the type $MXO_2CO_3$ (M = Na, K, Rb, Cs, or $NH_4$; X = Np(V), Pu(V), or Am(V)) were synthesized and studied by a powder x-ray method. The parameter of the hexagonal lattice varied with the method of obtaining the samples and the external conditions (moisture, temperature). The monocarbonates had the composition $MXO_2CO_3 \cdot nH_2O$ and could be hydrated and dehydrated without destroying the basic motif of the crystal structure. (tr-auth)

**27655** (ORO-4447-029) STUDY OF THE OXIDATION-REDUCTION KINETICS INVOLVED IN THE Np(V) + Fe(II) IN EQUILIBRIUM Np(IV) + Fe(III) SYSTEM IN NITRIC ACID SOLUTIONS. Jao, Y. (Tennessee Univ., Knoxville (USA)). Aug 1975. 62p. Dep. NTIS $6.25.

Thesis.

Ferrous nitrate-hydrazine is one of the more attractive alter-

nate reactants to the currently used reagent, ferrous sulfamate, for partitioning plutonium from neptunium and uranium. An understanding of the kinetics of the reduction of Np(VI) to Np(IV) by ferrous nitrate-hydrazine is needed before a satisfactory evaluation of the feasibility of this reductant in actinide element separations can be made. The purpose of this work was to study the kinetics and mechanisms of the reduction of Np(V) by Fe(II) and the oxidation of Np(IV) by Fe(III) in 1-2 M nitric acid solutions. The acid concentration range was chosen to include that typically used in the separation of plutonium from neptunium and uranium by solvent extraction with tributylphosphate. The forward and reverse rate constants, hydrogen ion dependence, temperature dependence, ionic strength effects and nitrate ion influence were determined. The proposed reaction mechanisms involve protonation of the $NpO_2^+$ ions and hydroxyoxygenation of $Np^{4+}$ ions. (LK)

**27656** (UCRL-13657) MASS SPECTROMETRIC STUDY OF THE MOLECULAR SPECIES FORMED DURING VAPORIZATION OF $UCl_4$ IN $Cl_2$, AND $AlCl_3$. Hildenbrand, D. L.; Cubicciotti, D. D. (Stanford Research Inst., Menlo Park, Calif. (USA)). 23 May 1975. 24p. Dep. NTIS $4.25.

For Univ. of California, Livermore.

Solid $UCl_4$ was heated in a graphite effusion cell, and the species that vaporized in vacuum and in the presence of $Cl_2$ and $AlCl_3$ were investigated by mass spectrometry. In vacuum, the vapor species formed was $UCl_4$. The observed vapor pressure of $UCl_4$ was in general agreement with the literature, but the temperature coefficient was different. In $Cl_2$, the molecule $U_2Cl_{10}$ was identified from its mass spectrum and its behavior while the $Cl_2$ pressure was varied. That molecule had been reported by Gruen and McBeth. A new vapor species, $UCl_5$, was also identified. In $AlCl_3$ the molecular species $UCl_4AlCl_3$ was identified from the mass spectrum and the dependence on $AlCl_3$ pressure. That molecule was different from the $UCl_4Al_2Cl_6$ observed by Gruen and McBeth. In the presence of $Cl_2$ plus $AlCl_3$ the molecular species $UCl_5AlCl_3$ was found in accord with results by Gruen and McBeth. Expressions for the partial pressures of the uranium-containing vapor species are given as a function of pressures of $Cl_2$ and $AlCl_3$ in the presence of solid $UCl_4$. (auth)

**27657** INCORPORATION OF $^{85}Kr$ INTO SOME ISOTHIOCYANATES AND THE STABILITY OF THE KRYPTONATES IN AIR. Uher, M.; Toelgyessy, J.; Harangozo, M.; Klehr, E. H. (Slovak Technical Univ., Bratislava). Isotopenpraxis; 11: No. 6, 216-219 (Jun 1975).

A number of isothiocyanates have been prepared and kryptonated by microdiffusion. Their stability in air was studied by counting the residual activity as a function of time. Initial specific activities were large enough for practical use, ranging from $4 \times 10^4$ to $3 \times 10^6$ cpm per 100 mg. Within 200 h in air, some kryptonated isothiocyanates lost as much as 80% of their initial activity. (auth)

**27658** PRODUCTION OF RADIOACTIVE LABELED TRACER COMPOUNDS. II. Organic Bromine Compounds Labeled with $^{82}Br$ Through Isotopic Exchange. Otto, R. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Leipzig). Isotopenpraxis; 11: No. 6, 220-223(Jun 1975). (In German).

In the present work, investigation of bromine isotope exchange between organic bromine compounds and dioxane dibromide labelled $^{82}Br$ is described. The addition of $AlCl_3$ renders possible exchange efficiency as a function of the structure of the organic compound to range up to 75% with exchange time being 300 min. $AlCl_3$ has a polarizing effect upon both R-Br and Br-Br bonds, thus accelerating the exchange process. A simple preparative and fast $^{82}Br$ labelling method is derived from the obtained results. It allows introduction of $^{82}Br$ into several organic bromine compounds of various structures. The method is especially to be recommended when monobromine compounds labelled $^{82}Br$ are to be produced. (auth)

**27659** MIXED LIGAND COMPLEX OF Th(IV). Sitaramalakshmi, C.; Venkateswarlu, C. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 13: No. 6, 625(Jun 1975).

Mixed ligand complex formation in Th(IV)-EDTA-gallic acid system has been investigated using the pH titration technique of Irving and Rossotti as modified by Sathe et al. The stability constant of the mixed complex is $4.5 \times 10^{34}$ at 28°. (auth)

**27660** HYDROLYSIS OF Np(III). Mefod'eva, M. P.; Krot, N. N.; Afanas'eva, T. V.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Bull. Acad. Sci. USSR, Div. Chem. Sci.; 23: No. 10, 2285-2287(Oct 1974).

Translated from Izv. Akad. Nauk SSSR, Ser. Khim.; 23: No. 10, 2370-2372(Oct 1974).

The hydrolysis constant of Np(III) was determined to be $(3.7 \pm 0.9) \times 10^{-6}$ mole 1 liter. Existing literature data for the lanthanide ions $Pr^{3+}$ and $Nd^{3+}$, which are close in properties and size, were used in the determination of the hydrolysis constant of Np(III). (LK)

**27661** CHEMICAL SHIFT ANISOTROPIES IN PARAMAGNETIC URANIUM FLUORIDES. Fukushima, E. (Los Alamos Scientific Lab., N. Mex. (USA)). pp 239-240 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th Ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

Temperature dependences of $^{19}F$ chemical shift components were measured in $(C_5H_5)_3UF$ powder. The shifts are axially symmetric from room temperature to 150°K and the two components are not proportional with each other. The shifts are not axially symmetric at lower temperatures indicating a probable phase transition. (auth)

**27662** DIFFUSION OF FISSION PRODUCTS IN ALPHA THORIUM. Fox, C. H. Jr. Raleigh, NC; North Carolina State Univ. (1974). 240p. University Microfilms Order No. 75-15,150. Thesis (Ph. D.)

Fission products were injected into thorium disks by the fission recoil doping method at concentrations approximating infinite dilution. Tantalum-wrapped samples were isothermally annealed in an evacuated quartz-kimax tube at 872 to 1177°C. Release of $^{133}Xe$ was monitored during the anneal using a shielded gamma ray spectrometer. For nonvolatile fission products, the samples were sectioned after the anneal for concentration profile analysis using the electropolishing method. Diffusion of Te and Xe is consistent with the accepted theory of vacancy diffusion of substitutional solute impurities in fcc metals. Diffusion of Ba and Ce is close to that of self-diffusion in thorium but is inconsistent with the Lazarus–LeClaire theory. The mechanism is substitutional-interstitial with the substitutional phase dominant. A strong correlation was observed between the activation energy and valence for impurity diffusion in thorium. The fast diffusion observed for $^{99}Mo$ is consistent with a substitutional-interstitial mechanism. A correlation exists between the ratio of the ionic radius for the impurity and host and the measured activation energy for impurity diffusion. Very low diffusion rates are indicated at the operating temperatures of the Unclad Metal Breeder Reactor. The diffusion of Mo will be the most significant of the fission products studied. (DLC)

**27663** HALIDE CHEMISTRY OF THE ELEMENT 114. Hoffmann, P. (Technische Univ. Darmstadt (F. R. Germany). Fachbereich Anorganische Chemie und Kernchemie). Radiochim. Acta; 20: No. 3, 115-117(1973). (In German).

The properties of such halide compounds of the element 114 are discussed as might be used for gas-phase separation of the element from a mixture produced by nuclear reactions, viz. $114Cl_2$, $114Cl_4$, $114F_4$. Boiling points and energies of dissociation are the properties evaluated by extrapolation. (auth)

**27664** USE OF ZIRCONIUM PHOSPHATE FOR STABILITY CONSTANT DETERMINATION OF URANIUM AND ANTIMONY CHLOROCOMPLEXES. Aly, H. F.; Abdel-Rassoul, A. A.; Zakareia, N. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Chemistry Dept.). Z. Phys. Chem. (Frankfurt); 94: No. 1-3, 11-18(Jan 1975).

A method is described for determining the formation constants of both uranium and antimony chlorocomplexes by cation exchange on zirconium phosphate (ZP). The distribution behavior of U(+6) and Sb(+5) between ZP and HCl is studied from acid solutions of different concentrations, 0.01 to 4.0 M. In both cases, the molar ratio(n) of the complexing agent to one mole of the metal ion was found to be almost one in the acid range studied. The overall formation constants are calculated according to Schubert, giving a mean anti beta = 39 ± 4 for uranium, and anti beta = 2.2 ± 0.6 for antimony chlorocomplexes. (GE)

**27665** STABILITY OF AMERICIUM(V) IN NITRIC ACID SOLUTIONS. Myasoedov, B. F.; Molochnikova, N. P.; Lebedev, I. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 30: No. 7, 1337-1343(Jul 1975). (In Russian).

The kinetics of oxidation of americium microamounts with ammonium persulfate in 0.1 M $HNO_3$ has been studied on heating over the temperature range 50–90°C in the absence of a catalyzer. Apparent rate constants have been calculated for the reaction of oxidation of Am(III) to Am(VI) with ammonium persulfate at different temperatures. The activation energy for the oxidation reaction has been determined to be 20.7 ± 0.8 kcal $mol^{-1}$. The rate of reducing Am(V) has been studied as a function of various factors: concentration of ammonium persulfate and americium, acidity, and medium temperature. Apparent rate constants have been calculated for the reaction of reduction of Am(V). The activation energy for the reaction of reducing Am(V) has been

calculated to be 29.2 ± 2.8 kcal $mol^{-1}$. An equation is suggested for calculation of reducing Am(V) over a wide range of nitric acid and americium concentration and of the power of $\alpha$-radiation dose. Conditions have been found for maximum stability of Am(V) in nitric acid solutions. (auth)

**27666** HYPERFINE PARAMAGNETIC CORRECTIONS IN THE ACTINIDES. Kalish, R.; Shreter, U.; Grunzweig-Genossar, J. (Technion-Israel Inst. of Tech., Haifa. Dept. of Physics). Hyperfine Interactions; 1: No. 1, 65-80(Jun 1975).

The paramagnetic correction factors ($\beta$) for actinide ions are calculated, using relativistic expressions for the orbital contributions and a phenomenological expression for the core polarization contribution to the hyperfine field. Numerical results for $\beta$ are given for ions ranging from $Th^{3+}$ to $Cf^{4+}$ in various ionization states. The approximations used in the calculations and the validity of the results are discussed. The results of previous PAC experiments on actinide nuclei are re-examined in the light of the present calculations. (auth)

**27667** KINETICS OF THE REACTION BETWEEN PLUTONIUM(III) AND CHROMIUM(VI) IN AQUEOUS PERCHLORATE SOLUTIONS. Newton, T. W. (Los Alamos Scientific Lab., NM). Inorg. Chem.; 14: No. 10, 2394-2399(Oct 1975).

The oxidation of Pu(III) to Pu(IV) by Cr(VI) was studied in aqueous perchlorate solutions from 0.10 to 2.0 M in $HClO_4$. To a good approximation the initial rates are given by $k[Pu(III)][Cr(VI)][H^+]^2$, but k is increased slightly by increasing Cr(VI) and decreased markedly by Pu(IV). The reaction induces the oxidation of $I^-$ by Cr(VI) with a limiting induction factor of 2 equiv of $I^-$ oxidized per mole of Pu(IV) formed. The proposed mechanism involves the reversible formation of Cr(V) and is similar to that for the analogous oxidation of Fe(II) by Cr(VI). A small negative temperature coefficient was observed in 0.10 M $HClO_4$–0.90 M $LiClO_4$ solutions and the activation parameters for the first rate determining step are DELTA F* equals 11.81 +- 0.03 kcal/mol, DELTA H* equals –0.75 +- 0.75 kcal/mol, and DELTA S* equals –42 +- 2.6 cal/(mol deg). (auth)

**27668** THERMODYNAMIC PROPERTIES OF GASEOUS URANIUM HYDROXIDE. Dharwadkar, S. R.; Tripathi, S. N.; Karkhanavala, M. D.; Chandrasekharaiah, M. S. (Bhabha Atomic Research Centre, Trombay, India). pp 455-465 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB–380(Vol.2); CONF-741030–P2.

Thermodynamic data for the homogeneous reaction of UO, (g) with $H_2O$(g), in the temperature range of 1325 to 1675°K, were evaluated by studying the partial pressure of uranium vapor over $U_3O_8$ in the presence of dry and moist oxygen. The standard free energy change ($\Delta G_f^\circ$) for the reaction of $U_3O_8$ with dry oxygen could be represented as: $\Delta G_f^\circ$ (kJ) = (369.9 ± 7.9) – (145.2 ± 4.9) × $10^{-3}$T and the free energy change ($\Delta G_2^\circ$) for the reaction of $U_3O_8$ with wet oxygen (water vapor of 23 torr partial pressure) could be represented as: $\Delta G_2^\circ$ (kJ) = (183.8 ± 7.7) – (52.2 ± 5.6) × $10^{-3}$T. From $\Delta G_1^\circ$ and $\Delta G_2^\circ$ the free energy change ($\Delta G_3^\circ$) for the reaction of $UO_3$(g) with $H_2O$(g) was evaluated as: $\Delta G_3^\circ$ (kJ) = – (186.1 ± 15.6) + (93.0 ± 10.5) × $10^{-3}$T. From the large enthalpy change for this gas phase reaction it was deduced that a species of the type $UO_2(OH)_2$ is formed in the vapor phase, rather than a structure with fewer than four U–O bonds. (auth)

**27669** SOLUBILITY BEHAVIOR OF $PuF_3$ IN FLUORIDE SALT MIXTURES OF INTEREST IN MOLTEN SALT REACTOR TECHNOLOGY. Sood, D. D.; Iyer, P. N. (Bhabha Atomic Research Centre, Trombay, India). pp 489-498 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB–380(Vol.2); CONF-741030–P2.

The solubility of plutonium trifluoride in molten salts containing fluorides of lithium, beryllium, and thorium was determined in the temperature range of 550 to 800°C to assess the chemical feasibility of a plutonium-fueled molten salt reactor. The minimum solubility was found to be 0.85 mol% at 550°C, which is higher than the $PuF_3$ concentration calculated as the minimum requirement for a plutonium start-up molten salt reactor. Empirical correlations which can predict the solubility of $PuF_3$ in these ternary fluoride mixtures within 5 to 10% were derived from the solubility data. The solubility of $PuF_3$ was also determined in binary melts containing fluorides of lithium and thorium over a similar temperature range to obtain an understanding of the solubility behavior of $PuF_3$. The data on the solubility of $PuF_3$ in binary and ternary salt mixtures containing LiF, $BeF_2$, and $ThF_4$ were used to calculate the activity coefficients of $PuF_3$ in these molten salt media. The partial molal heat of mixing and excess partial molal entropy of mixing of liquid $PuF_3$ with molten fluoride media were also calculated. For all the salt compositions, the heat and entropy values are negative, ranging from –1.5 to –7.5 kcal/mol for $H_{PuF_3}$ and –2.0 to –8.9 entropy units for $S_{PuF_3}^E$. In the binary salt melts, the heat and entropy effects are low for compositions close to $2LiF-BeF_2$ and $2LiF-ThF_4$, indicating that these melts are more ordered. In the ternary salt melts, the heat and entropy effects have minima for salt compositions having a small value for parameter $D_t = ThF_4/(ThF_4 + 1.7\ BeF_2)$, and approach a plateau beyond $D_t = 0.5$. (auth)

**27670** ADDITION COMPOUNDS OF URANYL CHELATES WITH MONODENTATE ANIONIC (LiCl, LiBr, LiI, AND $NH_4NCS$) AND NEUTRAL LIGANDS (HEXAMETHYLPHOSPHORAMIDE, TRIPHENYLPHOSPHINE OXIDE, AND PYRIDINE N-OXIDE). Bhattacharyya, B. C.; Roy, S. (Jadavpur Univ., Calcutta). Indian J. Chem.; 13: No. 7, 708-710(Jul 1975).

Uranyl chelates of N-phenylbenzo-, N-phenylcinnamo- and N-phenylphenylaceto-hydroxamic acids and monodentate anionic nucleophiles (Cl-, Br-, I-, SCN-) as well as their addition compounds with hexamethylphosphoramide, tripheylphosphine oxide and pyridine N-oxide have been obtained and characterized on the basis of conductance, molecular weight, electronic and IR spectral data. Seven coordination for U(VI) in some of the complexes is indicated. (auth)

**27671** ROLE OF ANIONS IN THE KINETICS AND MECHANISM OF THE Fe(III)–U(IV) REACTION. El-Tantawy, Y. A.; Ezzat, I. I. (Alexandria Univ. (Egypt). Dept. of Chemistry). Z. Phys. Chem. (Frankfurt); 95: No. 1-3, 93-106(1975).

The kinetics and mechanism of the reaction 2Fe(III) + U(IV) = 2F3(II) + U(VI) were studied in 1M $HClO_4$ in the presence of sulfates, bisulfates, dihydrogenphosphates or the iodide, bromide, or chloride ions. The dependence of the rate constant on the acid concentration in the range tested was found and the dependence on the anions at relatively low values determined. Based on proposed probable mechanisms the rate law was derived. (GE)

**27672** INVESTIGATIONS OF THE DECONTAMINABILITY OF PROTECTIVE COATINGS BY THE KARLSRUHE METHOD. Kunze, S. (Kernforschungszentrum Karlsruhe (F. R. Germany). Abt. Dekontaminationsbetriebe). Ind.-Lackier-Betr.; 42: No. 8, 297-303(1974). (In German).

A method of decontaminability testing is described. This method was developed in Karlsruhe over 10 years ago and 526 protective coatings have been tested so far. The results are summarized in tables. A major part of these coatings, lacquers, and varnishes were used in contamination–exposed rooms and operations buildings of the Nuclear Research Centre by way of trial and for observation. This observational experience corresponds to the experimental results. (auth)

**27673** STUDIES ON Cu (II), Co (II, Ni (II), Zn (II), AND $UO_2$ (II) COMPLEXES OF SCHIFF BASES DERIVED FROM SALICYLALDEHYDE AND TRIS(HYDROXYMETHYL)AMINOMETHANE AND 2-AMINO-2-METHYLPROPANEDIOL. Rustagi, S. C.; Rao, G. N. (Indian Inst. of Tech., New Delhi). Indian J. Chem.; 13: No. 7, 702-704(Jul 1975).

Two new Schiff base ligands, a pentadentate one ($DH_2$) and a tetradentate one ($EH_2$), have been prepared respectively by the reaction of salicylaldehyde with tris(hydroxymethyl)aminomethane and 2-amino-2-methylpropanediol. Coordination complexes of copper(II), cobalt(II), nickel(II), zinc(II) and uranium(VI) with the new ligands have been isolated. Structures of the complexes are discussed on the basis of elemental analysis, visible and infrared spectra and magnetic moments. Thermal decomposition of the complexes has been also investigated. (auth)

**27674** KINETICS OF METAL HALIDE SEPARATION PROCESSES. Crawford, R. E. Kensington, Australia; University of New South Wales (1974). vp. Librarian, Univ. of New South Wales, Kensington, Australia.

Thesis (Ph. D.).

From a review of uranium isotope separation methods, the adsorption of $UF_6$ using a gas–solid chromatographic technique was chosen for experimental study to determine if an isotope effect was associated with the adsorption. No isotope effect was detected in the experiments. Published theoretical estimates of separation factor for adsorption of $UF_6$ on NaF vary from 1.005 at 350°K to < 1.0005 at 340°K. The negative results obtained experimentally tend to confirm the lower separation factors although diffusion, and nonequilibrium effects which were encountered acted against a basic separation effect. From the probable low separation factors and the inefficiencies of the gas chromatographic system with these adsorbents, it was concluded that uranium enrichment by gas–solid chromatography is not a viable process. (JGB)

**27675** CONCEPTUAL PROBLEMS IN NOBLE GAS AND FLUORINE CHEMISTRY. II. Nonexistence of Radon Tetrafluoride. Liebman, J. F. (Univ. of Maryland, Baltimore). Inorg. Nucl. Chem. Lett.; 11: No. 10, 683-685(Oct 1975).

Reasons for the apparent failure of radon to form tetravalent compounds are examined. Experimentally it has been found that divalent radon compounds are highly ionic. It is anticipated that fluorination of radon beyond the divalent species proceeds through the intermediacy of the $RnF^+$ ion. The considerably higher positive charge on radon compared to e.g. Xe suggests that further oxidation fluorination would require activation energy for $RnF^+$. Furthermore the relatively ionic lattice of $RnF_2$ stabilizes the $RnF^+$ ion (c.f. $RnF^+F^-$) and so mitigates against fluorination; radon may therefore be blocked kinetically at the divalent stage. (UK)

**27676** ELECTROCHEMICAL AND SPECTROPHOTOMETRIC STUDY OF EDTA COMPLEXES OF PLUTONIUM IONS. Plutonium(V) and (VI). Cauchetier, P.; Guichard, C. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Inorg. Nucl. Chem.; 34: No. 7/8, 1771-1778(Jul 1975). (In French).

The influence of EDTA concentration and pH on the behavior of plutonium (V) and (VI) in solution was studied. Plutonium (VI) is reduced by EDTA as soon as pH reaches about 1. The kinetic of this reduction increases with the EDTA concentration and pH. One EDTA mole reduces a number of $PuO_2^{2+}$ ions (about 7 at the highest) variable with pH and the ratio of species present: that means that several competitive reactions exist. The absorbance spectra of the plutonium (V) and (VI) complexes are shown. It appears that plutonium (VI) gives with EDTA three complexes different from one another in number of bound protons: $PuO_2Y^{2-}$ ($pK_C^{VI} \simeq 14.6$), $HPuO_2Y^-$ ($pK_1^{VI} \simeq 4.0$), $H_2PuO_2Y$ ($pK_{\Delta 2}^{VI} \simeq 1.2$). Plutonium (V) gives at least one and probably two complexes: $PuO_2Y^{3-}$ ($pK_C^V \simeq 11.7$ to 12.9 if only this complex exists) and $HPuO_2Y^{2-}$ ($pK_A^V \sim 4.2$). The polarograms are also shown. (auth)

**27677** GENERAL METHOD FOR THE PREPARATION OF TRITIATED POLYCHLOROBIPHENYLS OF HIGH SPECIFIC ACTIVITY: 2,2',5,5'-TETRACHLOROBIPHENYL-[$^3$H] AND 2,2',-4,4',5,5'-HEXACHLOROBIPHENYL-[$^3$H]. Hutzinger, O.; Safe, S. (National Research Council of Canada, Halifax). Bull. Environ. Contam. Toxicol.; 7: 374-375(Jun 1972).

A general method for preparing tritiated chlorobiphenyls of high specific activity by isotopic exchange is reported. Acid catalyzed exchange gave low incorporation of the hydrogen isotope, but chlorobiphenyls in which amino groups activated the electrophilic exchange process gave good incorporation. (LK)

**27678** OPTICAL ISOTOPE SHIFT IN $^{144}$Ce. Fischer, W.; Huehnermann, H.; Mandrek, K.; Meier, T. (Marburg Univ. (F. R. Germany). Fachbereich Physik); Aumann, D. C. (Technische Univ. Muenchen, Garching (F. R. Germany). Inst. fuer Radiochemie). Physica; 79: No. 1, 105-112(Jan 1975).

The radioactive cerium nuclide $^{144}$Ce (half life $T_{\frac{1}{2}}$ = 284 d) was separated chemically from fission products of uranium. The isotope shifts in the Ce I lines $\lambda\lambda$ = 4632Å, 4846Å, 5230Å, 5291Å, 5297Å were measured with the aid of a pressure-scanned Fabry-Perot interferometer. In all these lines the isotope shift $\Delta\sigma_{IS}$ ($^{144}$Ce-$^{142}$Ce) was found to be about 85% of $\Delta\sigma_{IS}$ ($^{142}$Ce-$^{140}$Ce). An interpretation in terms of nuclear radii and nuclear deformation is given. (auth)

**27679** HEAT CAPACITIES OF $^{242}PuF_3$ AND $^{242}PuF_4$ FROM 10 TO 350°K, AND OF $^{244}PuO_2$ FROM 4 TO 25°K: DERIVED ENTROPIES AND OTHER THERMODYNAMIC PROPERTIES AT 298.15°K. Flotow, H. E.; Osborne, D. W.; Fried, S. M.; Malm, J. G. (Argonne National Lab., IL). pp 477-488 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

The heat capacities of $^{242}PuF_3$ and $^{242}PuF_4$ have been determined from 20 to 350°K by the quasi-adiabatic method with intermittent electrical heating. From 18 to 58°K the measured temperature drifts with no electrical heating were compared with the measured heat capacities to evaluate the radioactive self-heating rate, (1.210 +- 0.004) x $10^{-4}$ W/g Pu. Heat capacities between 10 and 20°K were determined from the radioactive self-heating rate and temperature drifts with no electrical heating. The data for $^{242}PuF_3$ showed a transition, believed to be non-magnetic in origin, in the region of 119°K. Magnetic susceptibility measurements indicate that $^{242}PuF_3$ becomes antiferromagnetic below about 9°K. The results for $^{242}PuF_4$ showed no anomalous effects. The heat capacity of $^{244}PuO_2$ has been obtained between 10 and 25°K by the intermittent electrical heating technique. No thermal anomaly was detected from 4 to 25°K. Evidence for a slight amount of radiation crystal damage was detected for $^{242}PuF_3$ after holding its temperature below 9°K overnight. $^{242}PuF_4$ and $^{244}PuO_2$ showed no radiation damage effects. Heat capacities and derived entropies, enthalpies and Gibbs energies divided by temperature are presented in tabular form at selected temperatures to 350°K. Comparisons of these data with other data and estimates in the literature are made. (auth)

## *Radioactive Waste Treatment*

*Refer also to abstract 28729.*

**27680** (ARH-SA-217) REMOVAL OF ACTINIDES FROM NUCLEAR FUEL REPROCESSING WASTE SOLUTIONS WITH BIDENTATE ORGANOPHOSPHORUS EXTRACTANTS. Schulz, W. W.; McIsaac, L. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Aug 1975. Contract E(45-1)-2130. 32p. (CONF-750913-13). Dep. NTIS $4.75.

From 4th international transplutonium elements symposium; Baden-Baden, F.R. Germany (13 Sep 1975).

The neutral bidentate organophosphorus reagents DBDECMP (dibutyl-N,N-diethylcarbamylmethylenephosphonate) and its dihexyl analogue DHDECMP are candidate extractants for removal of actinides from certain acidic waste streams produced at the U. S. ERDA Hanford and Idaho Falls sites. Various chemical and physical properties including availability, cost, purification, alpha radiolysis, and aqueous phase solubility of DBDECMP and DHDECMP are reviewed. A conceptual flowsheet employing a 15 percent DBDECMP (or DHDECMP)–$CCl_4$ extractant for removal (and recovery) of Am and Pu from Hanford's Plutonium Reclamation Facility acid waste stream (CAW solution) was successfully demonstrated in laboratory-scale mixer-settler tests; this extraction scheme can be used to produce an actinide-free waste. A 30 percent DBDECMP-xylene flowsheet is being tested at the Idaho Falls site for removal of U, Np, Pu, and Am from Idaho Chemical Processing Plant first-cycle high-level raffinate to produce an actinide-free (less than 10 nCi alpha activity/gram) waste. (auth)

**27681** (CONF-750902-9) VOLUME REDUCTION AND SALVAGE CONSIDERATIONS FOR PLUTONIUM-CONTAMINATED FERROUS METAL. Levitz, N.; Gerding, T. H.; Winsch, I. O.; Cannon, T. F.; Steindler, M. J. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 23p. Dep. NTIS $4.25.

From 80th national meeting of the American Institute of Chemical Engineers; Boston, Massachusetts, USA (7 Sep 1975).

A survey of the literature and discussions at pertinent sites operated for ERDA disclosed an inventory exists of plutonium-contaminated metal. Reliable assay of much of the waste for plutonium content requires reliable sampling and is virtually impossible because of its heterogeneous nature (size, shape, configuration). Furthermore, reliable methods for assaying to the presently required plutonium level of 10 nCi/g of matrix are not commercially available. Work on assay methods, particularly nondestructive assay (NDA) techniques, continues to be monitored. Recent work with liquid scintillators for monitoring neutrons appears to have some potential for our application and is being pursued. Transforming the metal waste to a standard form such as an ingot or slab by melting (melt-refining) should facilitate both sampling and assay and has been selected for exploratory study. Present emphasis of work is on ferrous materials. Small-scale studies on the melt-refining of steel contaminated with plutonium are just getting started in a glove box facility. Support work on noncontaminated steel is in progress using $UO_2$ as a stand-in for $PuO_2$. The initial phase of work in the support studies is concerned with establishing operating procedures and finding crucible and slagging materials that are compatible. Preliminary results in steel-melting tests without slags indicate some of the commercial fire-brick materials may be satisfactory as crucibles. $UO_2$, added as a stand-in for $PuO_2$ in the support work, appears to be not wetted by the molten steel and remains in the crucible when the molten steel is poured into a mold. Quantitative information on the final distribution of uranium is being developed for presentation orally. Crucible-slag combinations are undergoing compatibility testing in the support studies. Initial work with cryolite as a slag proved very corrosive to a MgO crucible. Work with plutonium will focus on establishing the distribution of plutonium (oxide) in the various materials, i.e., ingot, slag crucible. An ultimate goal of this work is the decontamination of plutonium-contaminated metal in the light of criteria for re-use release, or disposal. (auth)

**27682** (HEDL-TME-75-41) COMMERCIAL ALPHA WASTE PROGRAM. Quarterly Progress Report, October–December 1974. Cooley, C. R. (comp.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1975. Contract AT(45-1)-2170. 47p. Dep. NTIS $4.00.

This is the third Quarterly Progress Report on the Commercial Alpha Waste Program being conducted at the Hanford Engineering Development Laboratory (HEDL) for the Division of Waste Management and Transportation, USERDA. Data on waste generation during commercial fabrication of FFTF fuel are discussed. Expected volumes and activity levels of waste generated during commercial fuel reprocessing operations are also discussed. Progress to date on development of the acid digestion process for treating combustible wastes is discussed as well as work on product storage and disposal of wastes. Data on compaction and incineration of HEPA filters are presented. (auth)

**27683** (ICP-1080) ACTINIDE REMOVAL FROM ICPP WASTES. McIsaac, L. D.; Baker, J. D.; Tkachyk, J. W. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). Aug 1975. Contract E(10-1)-1375. 54p. Dep. NTIS $5.45.

The actinide removal program at the ICPP is discussed and potential separation procedures reviewed. Extensive extraction and stripping data are reported for the most promising extractants: dibutylbutyl phosphonate (DBBP), dihexyl-N, N-diethylcarbamylmethylemephosphonate (DHDECMP) and the butyl homologue, DBDECMP. Both synthetic and actual ICPP nuclear fuel reprocessing waste have been used. Solubility measurements for DHDECMP and DBDECMP are also reported. Analytical procedures developed for actinide analysis in ICPP waste are outlined. A conceptual process flowsheet for actinide removal at the ICPP is presented. (auth)

**27684** (INIS-mf-1640, pp 489-502) EXPERIENCE WITH IODINE SORPTION UNITS AT THE C.E.N./S.C.K. Fieuw, G.; Boulenger, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Mar 1974. (In French).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973). (Commission of the European Communities, Brussels (Belgium)).

At the C.E.N./S.C.K. the air of the cells for the production of $^{131}I$ from irradiated tellurium oxide is filtered by activated carbon before being released to the atmosphere. The efficiency of the filters is verified periodically whereas the $^{131}I$ release by the chimneys is monitored continuously. The ventilation rate is 400 $m^3/hr$. The I concentration upstream from the filters is of the order of $10^{-10}$ $g/m^3$. A minimum yield of 95% is required. The verification procedure and the results obtained are reported and discussed. (tr-INIS)

**27685** (MLM-2244) MOUND LABORATORY ACTIVITIES ON THE REMOVAL OF RADIONUCLIDES FROM WASTEWATER USING BONE CHAR. Blane, D. E.; Murphy, E. L. (Mound Lab., Miamisburg, Ohio (USA)). 15 Sep 1975. Contract E-33-1-GEN-53. 18p. Dep. NTIS $4.00.

Bone char, a natural product which is obtained from granulated cattle bone, was determined to be the optimum phosphate for large-scale removal of plutonium from wastewater. Particles in the 74 to 105 mu range gave the best combination of decontamination factors and flow rates. Small-scale pilot runs with two bone char columns in series were investigated both with and without pretreatment of the influent water. In the pilot runs thus far conducted, the capacity of bone char for ionic plutonium was never exceeded. However, partial regeneration (17 percent) of the bone char can be achieved using 1M $Na_2CO_3$ and 0.1M $Na_2HPO_4$. Studies were made using a bone char column (20 in. high and 10 in. in diameter) preceded by a 0.1 mu filter. Results from these pilot runs yielded effluent with less than 1 dis/min/ml at flow rates from 0.5 to 1.5 gal/min. High pressure drops (60 to 65 psig) were noted in these columns, but it was found that pressure drops could be lowered to less than 45 psig by washing the particles free of fines. At pH's higher than 9, flocculent evaluations showed that Purifloc A-23 and Nalco C-610 produced the best overall characteristics when floc size, settling rates, and solution clarity were considered. (auth)

**27686** IMPROVEMENTS IN OR RELATING TO GAS CLEANING MEANS. Strong, R. E. (to United Kingdom Atomic Energy Authority). British Patent 1,392,719/B/. 30 Apr 1975. Filed date 14 Sep 1971. 3p.

The apparatus described aims at providing improved gas cleaning. It comprises a vessel containing a column of loosely packed fibrous material. A gas inlet is provided at the lower end of the vessel and a gas outlet at the upper end. Provision is also made for the entry of further fibrous material at the gas outlet end, and for the entry of liquor such as $HNO_3$, into the gas inlet end, with means allowing removal of the liquor from the gas inlet end. Comsumption of the fibrous material takes place mainly in the band closest to the gas inlet, and behind this band there is normally a loose mixture of corrosion products and trapped material which is capable of solution or suspension in a liquid such as $HNO_3$, and which may be removed by suction or drainage. Scrub liquor may be introduced at an intermediate point in the column. The fibrous material may comprise crimped and coiled knitted steel wire, in interference fit in the vessel. (UK)

## Radioisotope Production

*Refer also to abstract 28329.*

**27687** (IEA-371) RAPID RADIOCHEMICAL ION-EXCHANGE SEPARATION OF IODINE FROM TELLURIUM: A NOVEL RADIOIODINE-132 GENERATOR. Abrao, A. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jan 1975. 6p. Dep. NTIS (US Sales Only) $4.00.

The findings that tellurium ions form a soluble cationic complex with thiourea in acid medium are reported. The cationic tellurium-thiourea species is strongly absorbed on a cationic ion exchanger. The retention of tellurium on the resin enables many interesting separation schemes for tellurium from various ions. With special interest, the separation of iodine from tellurium was studied. An efficient and convenient $^{132}I$ generator is described, the radioiodine being eluted with water on 9 g/l NaCl when desired. (auth)

**27688** (JINR-12-7525) RAPID GAS THERMOCHROMATOGRAPHIC METHODS OF RADIOACTIVE ELEMENTS EVOLUTION. 5. Formation of Volatile Rhenium Oxides and Hydroxides in the Rhenium-Tungsten System and Their Gas Thermochromatographic Behaviour. Bayar, B.; Votsilka, I.; Zajtseva, N. G.; Novgorodov, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 18p. (In Russian). INIS.

The thermochromatographic behavior of microquantities of Re in a current of He and $O_2$ was studied as a function of the content of water vapor in the gas carrier, time, and sublimation temperature. On the basis of experimental results a rapid method was developed for obtaining from irradiated W targets radiochemically pure, carrier-free radioactive preparations of Re. (tr-INIS)

**27689** (JINR-R-12-7280) RAPID GAS-THERMOCHROMATOGRAPHIC METHODS OF RADIOACTIVE ELEMENT SEPARATION. 3. Formation and Thermochromatographic Behaviour of Ultramicroamounts of Volatile Tungsten Oxides and Hydroxides. Bayar, B.; Votsilka, I.; Zajtseva, N. G.; Novgorodov, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 17p. (In Russian). INIS.

The high-temperature sublimation (> 1000°C) and the thermochromatographic behavior of microquantities of W in an oxygen current were studied as a function of the vapor pressure of water, in the gas carrier, the velocity of the gas carrier, and the sublimation time. On the basis of the data obtained, a fast gas thermochromatographic method was developed for the separation of carrier-free, radiochemically pure W from Ta and Au targets irradiated with high-energy protons. (tr-auth)

**27690** (JINR-R-12-7340) RAPID GAS-THERMOCHROMATOGRAPHIC METHODS OF RADIOACTIVE ELEMENT EXTRACTION. IV. Extraction of Neutron-Deficit Zr and Nb Isotopes from Silver Chloride Melt. Bayar, B.; Votsilka, I.; Zaitseva, N. G.; Novgorodov, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 18p. (In Russian). INIS.

Using thermodynamic data, a massive silver chloride target was selected. It was decomposed and the micro amounts of neutron-deficient Zr and Nb isotopes formed in nuclear decay were rapidly extracted in the gas phase. Conditions for further gas-chromatographic processing of these elements were found, which produced pure short-lived (up to 1.5 min) isotopes. (tr-auth)

**27691** (JINR-R-12-7928) THERMOCHROMATOGRAPHIC SEPARATION OF I, At AND Hg-VOLATILE PRODUCTS OF NUCLEAR REACTIONS. Ajkhler, B.; Domanov, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1974. 11p. (In Russian). INIS.

The elements I, At, and Hg were separated in a thermochromatographic column filled with powdered quartz on whose surface silver had been applied, using air as the carrier gas. The precipitation temperatures, the half-widths of the peaks, and the separation efficiency were determined. The method described may be used for separation of the elements named in an on-line regime in an accelerator beam. (tr-auth)

**27692** SEPARATION OF CARRIER FREE $^{54}Mn$ AND $^{58}Co$ FROM NEUTRON IRRADIATED IRON AND NICKEL. Mirza, M. Y. (Pakistan Inst. of Nuclear Science and Technology,

Rawalpindi. Isotope Production Div.). Radiochim. Acta; 20: No. 3, 135-137(1973).

A simple method using ion exchange resin was worked out for the separation of carrier-free $^{54}Mn$ and $^{58}Co$ from neutron-irradiated iron and nickel of natural isotopic abundance. The separation of $^{54}Mn$ by anion exchange resin followed by cation exchange resin gave a pure product free from Fe, Co, Ni, Cr, Zn, and Cu while the $^{58}Co$ activities separated by anion exchange resin gave a satisfactory product. About 98% activities were recovered in both cases. (auth)

**27693** DISTRIBUTION OF SOME ISOTOPES ON ZIRCONIUM TELLURATE AND BISMUTH TELLURATE: INORGANIC ION EXCHANGERS. Rahman, M. K.; Huq, A. M. S. (Atomic Energy Centre, Dacca (Bangladesh)). Radiochim. Acta; 20: No. 3, 108-109(1973).

The distribution of some isotopes viz. $^{137}Cs$, $^{144}Ce$ and $^{106}Ru$, which are obtained as appreciable yield in fission products, was studied under different experimental conditions using Zr tellurate and Bi tellurate. The effects of pH and concentration on the distribution of isotopes on the above mentioned exchangers were evaluated. The results indicated that $^{144}Ce$ isotope does not exchange with Zr tellurate and $^{137}Cs$ isotope behaves similarly with Bi tellurate. The findings further suggest the possibility of selective separation of $^{137}Cs$, $^{144}Ce$ and $^{106}Ru$ from their mixture. (auth)

## *Reactor Fuel Reprocessing*

*Refer also to abstracts 27936, 28019, 28491, 28710, 28716, 30220, and 30404.*

**27694** (BLG-500) REPROCESSING TECHNOLOGY OF LIQUID METAL COOLED FAST BREEDER REACTOR FUEL. Baetsle, L. H.; Broothaerts, J.; Heylen, P. R.; Eschrich, H.; Van Geel, J. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Nov 1974. 58p. Dep. NTIS (US Sales Only) $6.00.

All the important aspects of LMFBR fuel reprocessing are critically reviewed in this report. Storage and transportation techniques using sodium, inert gas, lead, molten salts and organic coolants are comparatively discussed in connection with cooling time and deactivation technique. Decladding and fuel disaggregation of $UO_2$-$PuO_2$ fuel are reviewed according to the present state of R & D in the main nuclear powers. Strong emphasis is put on voloxidation, mechanical pulverization, and molten salt disaggregation in connection with volatilization of gaseous fission products. Release of fission gases and the resulting off-gas treatment are discussed in connection with cooling time, burn up and disaggregation technique. The review is limited to tritium, iodine, xenon-krypton and radioactive airborne particulates. Dissolution, solvent extraction and plutonium purification problems specifically connected to LMFBR fuel are reviewed with emphasis on the differences between LWR and fast fuel reprocessing. Finally the categories of wastes produced by reprocessing are analyzed according to their origin in the plant and their alpha emitters content. The suitable waste treatment techniques are discussed in connection with the nature of the wastes and the ultimate disposal technique. (auth)

**27695** (CONF-740308-, pp 39-82) FEATURES OF THE NUCLEAR CYCLE RELEVANT TO SAFEGUARDS. Miranda, U. (EURATOM, Luxembourg). 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

This paper describes the fuel cycle characteristics in the European Community which are relevant to the application of safeguards. It also describes the safeguards procedures which are to be applied as a result of the Verification Agreement. Examples are given. The installations are listed and overall figures given for stocks and imports in different years 1960 to 1972 and categories of use. (DLC)

**27696** (CONF-740308-, pp 183-211) VALUE AND USE OF ISOTOPIC CORRELATIONS IN IRRADIATED FUELS. Berg, R. (Eurochemie, Mol, Belg.); Foggi, C.; Koch, L.; Kraemer, R.; Woodman, F. J. 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

Correlations between changes in the isotopic composition of irradiated fuels are being applied for safeguards purposes. These correlations include those based on heavy isotopes, stable fission products, and radioactive fission products. Present experience with this method are summarized, theoretical studies are surveyed, and its applications are illustrated. Future prospects are also considered. (19 fig) (DLC)

**27697** (ORNL-5011, pp 99-132) FUEL PROCESSING FOR MOLTEN-SALT REACTORS. Hightower, J. R. Jr. Jun 1975.

In molten-salt reactor program. Semiannual progress report for period ending August 31, 1974. (Oak Ridge National Lab., Tenn. (USA)).

Progress is reported on the development of processes for the isolation of protactinium and for the removal of fission products from molten-salt breeder reactors. The metal transfer experiment MTE-3 (for removing rare earths from MSRE fuel salt) was completed and the equipment used in that experiment was examined. The examination showed that no serious corrosion had occurred on the internal surfaces of the vessels but that serious air oxidation occurred on the external surfaces of the vessels. Analyses of the bismuth phases indicated that the surfaces in contact with the salts were enriched in thorium and iron. Mass transfer coefficients in the mechanically agitated nondispersing contactors were measured in the Salt/Bismuth Flow-through Facility. The measured mass transfer coefficients are about 30 to 40 percent of those predicted by the preferred literature correlation, but were not as low as those seen in some of the runs in MTE-3. Additional studies using water–mercury systems to simulate molten salt-bismuth systems indicated that the model used to interpret results from previous measurements in the water–mercury system has significant deficiencies. Autoresistance heating studies were continued to develop a means of internal heat generation for frozen-wall fluorinators. Equipment was built to test a design of a side arm for the heating electrode. Results of experiments with this equipment indicate that for proper operation the wall temperature must be held much lower than that for which the equipment was designed. Studies with an electrical analog of the equipment indicate that no regions of abnormally high current density exist in the side arm. (JGB)

**27698** (ORNL-5047, pp 148-183) FUEL PROCESSING FOR MOLTEN-SALT BREEDER REACTORS. Hightower, J. R. Jr. Sep 1975.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Research progress on development of processes for the isolation of protactinium and the removal of fission products from molten-salt breeder reactors is reported. Studies were continued of the chemistry of fuel reconstitution, studies of autoresistance heating for use in a frozen-wall fluorinator, studies of mass transfer in agitated contractors using both molten-salt–bismuth and mercury-water systems, and installation of experimental equipment for a metal transfer experiment and a fuel reconstitution engineering experiment. In the studies of the chemistry of fuel reconstitution, it was found that the rate of reduction of $UF_5$ dissolved in fuel salt by hydrogen gas followed zero-order kinetics at 550°C. (LK)

**27699** (ORNL-TM-4955) HTGR FUEL DEVELOPMENT: LOADING OF URANIUM ON CARBOXYLIC ACID CATION-EXCHANGE RESINS USING SOLVENT EXTRACTION OF NITRATE. Haas, P. A. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 48p. Dep. NTIS $5.45.

The reference fuel kernel for recycle of $^{233}U$ to HTGR's (High-Temperature Gas-Cooled Reactors) is prepared by loading carboxylic acid cation-exchange resins with uranium and carbonizing at controlled conditions. The purified $^{233}UO_2(NO_3)_2$ solution from a fuel reprocessing plant contains excess $HNO_3$ ($NO_3^-$/U ratio of approximately 2.2). The reference flowsheet for a $^{233}U$ recycle fuel facility at Oak Ridge uses solvent extraction of nitrate by a 0.3 M secondary amine in a hydrocarbon diluent to prepare acid-deficient uranyl nitrate. This nitrate extraction, along with resin loading and amine regeneration steps, was demonstrated in 14 runs. No significant operating difficulties were encountered. The process is controlled via in-line pH measurements for the acid-deficient uranyl nitrate solutions. Information was developed on pH values for uranyl nitrate solution vs $NO_3^-$/U mole ratios, resin loading kinetics, resin drying requirements, and other resin loading process parameters. Calculations made to estimate the capacities of equipment that is geometrically safe with respect to control of nuclear criticality indicate 100 kg/day or more of uranium for single nitrate extraction lines with one continuous resin loading contactor or four batch loading contactors. (auth)

# CONTROLLED THERMONUCLEAR RESEARCH

**27700** (N-73-28696/5) LITERATURE SURVEY ON PLASMA INSTABILITIES COVERING 1971 PUBLICATIONS. Part 2. Abstracts. Final Report. Auer, G.; Cap, F.; Hukla, P. (Innsbruck Univ. (Austria). Inst. fuer Theoretische Physik). 31 Dec 1972. 304p. (UNICP-SR-95-PT-2). NTIS $17.25.

Abstracts on publications concerned with plasma instabilities are reported which were published during the calendar year 1971. The following indices are given: (1) Name of instability-abstract number, and (2) list of all references, ordered according to periodical. (GRA)

**27701** TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. Volume 9, No. 7, 1975. Bibliography, Author Index, Subject Index, Appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 49p.

**27702** COUPLING OF MAGNETOACOUSTICAL WAVES IN A VISCOUS STRATIFIED PLASMA PLACED IN A VARIABLE MAGNETIC FIELD. I. Calculation of the Coupling Matrix. Gazi, R.; Zoler, D. (Centre des Recherches Techniques et Physiques, Iasi). Beitr. Plasmaphys.; 14: No. 6, 193-199 (1974). (In French).

The coupling of magnetoacoustical waves in a non-ideal plasma was studied for a physical situation which models the terrestrial magnetosphere. The general form of the coupling matrix was calculated. The matrix elements make it possible to determine the manner in which a certain wave can be reflected on the non-homogeneities of the plasma so that it can generate a wave of a different type. (tr-auth)

**27703** TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. Volume 9, No. 8, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 47p.

## Plasma Confinement and Heating

*Refer also to abstracts 27768, 28761, and 28970.*

**27704** (IPP-IV-56) MODEL FOR LASER HEATING OF SOLID TARGETS. Salvat, M. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Jan 1975. 22p. (In German). Dep. NTIS (US Sales Only) $4.25.

Consideration is given to a one-dimensional model for laser heating solid pellets with the aid of high energy lasers. Expressions are derived for the state parameters, the shock-wave and erosion front velocities as function of the laser lightwave length. (auth)

**27705** (MATT-1070) IMPURITY TRANSPORT IN FM-1. Schmidt, J. A.; Sauthoff, N. R.; Hawryluk, R. J. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Sep 1974. Contract AT(11-1)-3073. 11p. Dep. NTIS $4.00.

The confinement of Z equals 2 barium test ions in a Z equals 1 plasma was found to be strongly dependent on density and background plasma ion mass. Most of the characteristics of the parametric dependence of the barium confinement could be related to the superposition of an anomalous outward and a classical inward diffusion. (auth)

**27706** (MATT-1072) OPTIMIZATION OF FUSION POWER DENSITY IN THE TWO-ENERGY-COMPONENT TOKAMAK REACTOR. Jassby, D. L. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Oct 1974. Contract AT(11-1)-3073. 61p. Dep. NTIS $6.25.

The optimal plasma conditions for maximizing fusion power density P/sub f/ in a beam-driven D-T tokamak reactor (TCT) are considered. Given T/sub e/ equals T/sub i/ and fixed total plasma pressure, there is an optimal n/sub e/tau/sub E/ for maximizing P/sub f/, viz. n/sub e/tau/sub E/ equals $4 \times 10^{12}$ to $2 \times 10^{13}$ $cm^{-3}$ sec for T/sub e/ equals 3-15 keV and 200-keV D beams. The corresponding anti GAMMA equals (beam pressure/bulk-plasma pressure) is 0.96 to 0.70. P/sub fmax/ increases as T/sub e/ is reduced and can be an order of magnitude larger than the maximum P/sub f/ of a thermal reactor of the same beta, at any temperature. A lower practical limit to T/sub e/ may be set by requiring a minimum beam power multiplication Q/sub b/. For the purpose of fissile breeding, the minimum Q/sub b/ approximately 0.6, requiring T/sub e/ greater than or equal to 3 keV if Z equals 1. The optimal operating conditions of a TCT for obtaining P/sub fmax/ are considerably different from those for enhancing Q/sub b/. Maximizing P/sub f/ requires restricting both T/sub e/ and n/sub e/tau/sub E/, maintaining a bulk plasma markedly enriched in tritium, and spoiling confinement of fusion alphas. Considerable impurity content can be tolerated without seriously degrading P/sub fmax/, and high-Z impurity radiation may be useful for regulating tau/sub E/. (auth)

**27707** (MATT-1080) MAXIMUM POWER GAINS OF RADIO-FREQUENCY-DRIVEN TWO-ENERGY-COMPONENT TOKAMAK REACTORS. Jassby, D. L. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 12p. (CONF-740642-5). Dep. NTIS $4.00.

From 2nd topical conference on RF plasma heating; Lubbock, Texas, USA (20 Jun 1974).

Two-energy-component fusion reactors in which the suprathermal component (D) is produced by harmonic cyclotron "runaway" of resonant ions are considered. In one ideal case, the fast hydromagnetic wave at omega equals 2 omega/sub cD/ produces an energy distribution f(W) approximately constant (up to W/sub max/) that includes all deuterons, which then thermalize and react with the cold tritons. In another ideal case, f(W) approximately constant is maintained by the fast wave at omega equals omega/sub cD/. If one neglects (1) direct rf input to the bulk-plasma electrons and tritons, and (2) the fact that many deuterons are not resonantly accelerated, then the maximum ideal power gain is about 0.85 Q/sub m/ in the first case and 1.05 Q/sub m/ in the second case, where Q/sub m/ is the maximum fusion gain in the beam-injection scheme (e.g., Q/sub m/ equals 1.9 at T/sub e/ equals 10 keV). Because of nonideal effects, the cyclotron runaway phenomenon may find its most practical use in the heating of 50:50 D-T plasmas to ignition. (auth)

**27708** (MATT-1088) TWO-ENERGY-COMPONENT TOROIDAL FUSION DEVICES. Berk, H. L.; Furth, H. P.; Jassby, D. L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 14p. Dep. NTIS $4.00.

Injection of a superthermal ion component into a toroidal plasma can raise the fusion power density to levels considerably higher than those attainable in ordinary one-component plasmas. As a result, energy break-even in D-T can be attained in bulk plasmas with ntau-values as low as $10^{13} cm^{-3} sec$, at temperatures of approximately 5 keV. The optimal energy of the superthermal ion component is in the range 100-200 keV; injection-energy requirements can be reduced by adiabatic compression prior to or during the reaction phase. The appropriate ratio anti GAMMA of fast-ion pressure to bulk-plasma pressure is about 0.5. The stability of two-component tokamak plasmas has been examined, and is found to be favorable for parameters of practical interest. (auth)

**27709** (MATT-1092) EXPERIMENTS ON THE ADIABATIC TOROIDAL COMPRESSOR. Bol, K.; Cecchi, J. L.; Daughney, C. C.; DeMarco, F.; Ellis, R. A. Jr.; Eubank, H. P.; Furth, H. P.; Hsuan, H.; Mazzucato, E.; Smith, R. R. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 14p. (IAEA-CN-33/A4-2). Dep. NTIS $4.00.

Magnetic compressional heating of a tokamak discharge has been demonstrated successfully in the Adiabatic Toroidal Compressor (ATC). In addition to these investigations of compressional heating, other basic measurements have been made on ATC recently. These measurements are of interest because the ATC incorporates an air-core transformer and dispenses with the usual copper shell, two features likely to be found on future larger devices with smaller aspect ratios. The following topics will be discussed: (1) characteristics of the uncompressed discharges in ATC, including the dependence of beta/sub p/ on discharge parameters, bolometric measurements of the energy balance, measurements of the concentration of impurities; (2) MHD behavior and attempts at stabilization of the m equals 2 kink-tearing mode. (auth)

**27710** (MATT-1094) WAVE GENERATION AND HEATING IN THE ST TOKAMAK AT THE FUNDAMENTAL AND HARMONIC ION CYCLOTRON FREQUENCIES. Adam, J.; Chance, M.; Eubank, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 10p. (IAEA-CN-33/A3-2). Dep. NTIS $4.00.

Theoretical and experimental investigations are reported of wave generation and heating at the fundamental and the first harmonic of the ion cyclotron frequency. General theoretical considerations are followed by a description of experiments on the ST Tokamak designed to test the feasibility of this heating

scheme for providing the additional heating required for toroidal reactor operation. Two rf coils were used in an enlarged section of the ST vacuum vessel to allow operation up to approximately 1 MW of rf power. Wave generation efficiencies of approximately 90 percent were computed from theory and observed experimentally. The ion cyclotron (slow) wave is observed to be strongly damped but the fast hydromagnetic wave is seen to propagate many times around the machine so that standing toroidal eigenmodes are generated. The dependence of the eigenmode resonances on the density and magnetic field agrees closely with a theory based on a cylindrical, cold-plasma model. At omega equals 2omega/sub ic/, with relatively short rf pulses, the ion temperature approximately doubles and increases by approximately 100 eV, corresponding to a heating efficiency of approximately 20 percent. At omega equals omega/sub ic/ the ion temperature increases by only 25 percent under similar conditions. Longer rf pulses lead to a neutral particle influx which tends to constrict the current channel and leads to MHD instabilities. The impurity component of this influx also leads to enhanced ion heating by decreasing the ion-electron equipartion time. The temperature increases quoted are for conditions where the effect of this neutral influx was negligible. (auth)

**27711** (MATT-1098) MEASUREMENT OF THE ENERGY BALANCE IN ATC TOKAMAK. Hsuan, H.; Bol, K.; Ellis, R. A. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 17p. Dep. NTIS $4.00.

Gross properties of the energy balance in the ATC tokamak have been investigated. During the quasi-steady state phase of a normal discharge, the major part of the energy loss was found to be the limiters. Radiation and charge-exchange play minor roles during this quasi-steady state phase, but are nevertheless the dominant loss mechanisms at the termination of a discharge; and account for a substantial portion of the stored poloidal magnetic energy associated with the plasma current. (auth)

**27712** (MATT-1113) FAST-WAVE HEATING OF A TWO-COMPONENT PLASMA. Stix, T. H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Feb 1975. Contract AT(11-1)-3073. 56p. Dep. NTIS $6.00.

The use of the compressional hydromagnetic mode (also called the magnetosonic or, simply, the fast wave) is examined in some detail with respect to the heating of a tritium plasma containing a few percent deuterium. Efficient absorption of wave energy by the deuteron component is found when omega equals omega/sub c/ (deuterons), with Q/sub wave/ greater than or equal to 100. The dominant behavior of the high-energy deuteron distribution function is found to be f(v) approximately exp[3/2) integral/sup v/ dv [DELTA v]/[(DELTA v/sub perpendicular/)$^2$]], where [DELTA v] is the Chandrasekhar-Spitzer drag coefficient, and [(DELTA v/sub perpendicular/)$^2$] is the Kennel-Englemann quasilinear diffusion coefficient for wave-particle interaction at the deuteron cyclotron frequency. An analytic solution to the one-dimensional Fokker–Planck equation, with rf-induced diffusion, is developed, and using this solution together with Duane's fit to the D-T fusion cross-section, it is found that the nuclear fusion power output from an rf-produced two-component plasma can significantly exceed the incremental (radiofrequency) power input. (auth)

**27713** ABLATION OF HYDROGEN PELLETS IN HYDROGEN AND HELIUM PLASMAS. Joergensen, L. W.; Sillesen, A. H.; Oester, F. (Danish Atomic Energy Commission, Risoe). Plasma Phys.; 17: No. 6, 453-461(Jun 1975).

Measurements on the interaction between solid hydrogen pellets and rotating plasmas are reported. The investigations were carried out because of the possibility of refuelling fusion reactors by the injection of pellets. The ablation rate found is higher than expected on the basis of a theory of a shielding neutral gas layer. (auth)

**27714** HEATING OF HIGHLY IONIZED PLASMA IN THE LOWER HYBRID FREQUENCY RANGE. Takamura, S.; Okuda, T. (Nagoya Univ., Japan). Plasma Phys.; 17: No. 6, 435-445 (Jun 1975).

In order to examine the possibility of high-frequency heating of plasma in the lower hybrid frequency range, the interactions between the high-frequency electromagnetic field and a highly ionized plasma were studied. The absorption coefficients were measured at low power, while at high power the changes of the energy density of plasmas were examined. These experimental observations are compared with the theory of linear mode conversion. (auth)

**27715** PLASMA TURBULENCE: EXCEPTION OR RULE. Schrijver, H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Ned. Tijdschr. Natuurkd.; 41: No. 9, 99-101(3 May 1975). (In Dutch).

The characteristics of microinstabilities and turbulence in plasmas are discussed. Theoretical equations are developed for characteristic frequencies for both ions and electrons. A linear turbulent heating experiment for hydrogen is outlined, the apparatus involving a gas inlet, anode, cathode and magnetic field coils, with an electric filter circuit. Graphical results are quoted for frequency, resistance, voltage and current at time functions. It is concluded that small laboratory experiments are of limited value as the plasma turbulences tend to be overshadowed by classical microscopic instabilities. (auth)

**27716** INVESTIGATION OF THE COOLING AND FRAGMENTATION OF SPHERICAL TARGET HEATED BY LASER RADIATION. Gol'din, V. Ya.; Chetverushkin, B. N. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1768-1771(May 1975). (In Russian).

The heating and explosion of a deuterated polyethylene target in a chamber with air are investigated. It is shown that an ionization wave is formed in air which travels ahead of the shock wave. Estimation of the explosion energy according to the law of motion of a shock wave in air is shown to be applicable under strong radiation conditions. (auth)

## Plasma Diagnostics

**27717** (IPP-III-18) MEASUREMENT OF THE DIFFRACTION CHARACTERISTIC FOR THE 2 mm WAVE RADIATORS OF ASDEX. Cannici, B.; Lisitano, G.; Morandi, P. (Max–Planck–Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Jun 1975. 14p. Dep. NTIS (US Sales Only) $4.00.

Regarding the problem of probing beam refraction, the experience gained with the Tokamak Pulsator and the measurements of the simulated refraction pattern for the proposed ASDEX radiators show that the measurement of the density distribution of ASDEX at a wavelength of 2 mm is possible. (auth)

**27718** (JUL-1190) INTERNAL PLASMA DIAGNOSTIC WITH A MULTICHANNEL MAGNETIC PROBE SYSTEM USING AUTOMATIC DATA ACQUISITION. Korten, M.; Carolan, P. G.; Sand, F.; Waelbroeck, F. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Plasmaphysik). Apr 1975. 39p. Dep. NTIS (US Sales Only) $5.00.

A 20-channel magnetic probe system inserted into the plasma is used to measure spatial distributions of poloidal and toroidal magnetic fields in the pulsed toroidal high $\beta$-experiment TEE. Plasma parameters, e.g. the $\beta$-value, toroidal current density and radial pressure distribution were derived applying static equilibrium theory and can be calculated from the measurements. A data acquisition system used in conjunction with a process computer was operated to obtain the experimental data automatically and to perform the multiple computational tasks. The program system described was built to serve as a first stage of a more common software system applicable for computational data handling for different diagnostics of a plasma physics confinement experiment. (auth)

**27719** (KFTI-74-13) SUPERHIGH-FREQUENCY MEASURING METHOD OF THE ELECTRON DISTRIBUTION FUNCTION IN PLASMA. Gorozhanin, D. V.; Ivanov, B. I.; Miroshnichenko, V. A.; Prishchepov, V. P. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 29p. (In Russian). INIS.

A method was studied for measuring the function of electron distribution from longitudinal rates, based on ultra-high probing of the plasma in the region of electron cyclotron resonance. Formulas are presented related to the electron distribution function with a Doppler contour of the line of cylcotron absorption of the electromagnetic waves in the plasma. Resonator variant of the method ($\lambda$ = 10 cm) and a "free space" variant ($\lambda$ = 8 mm) are described. Measurements of the electron distribution function in the bunching plasma charge with a plasma density of $10^8$ to $10^{10}$ cm$^{-3}$ are presented, and results are given for experimental verification of the method. The possibility of using the method for measuring the electron beam modulation from the rate and for determining the direction of the electrical field in the plasma was investigated experimentally. (tr-auth)

**27720** (KFTI-74-17) ON THE PLASMA POTENTIAL MEASUREMENT BY MEANS OF PARTICLE BEAMS. Kalmykov, A. A.; Lavrent'ev, O. A. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 24p. (In Russian). INIS.

A method for measuring the potential of a plasma, the space distribution of the plasma potential, and other parameters by means of a beam of heavy ions and change in the charged state of the probing ions in the plasma was examined. The value of the plasma potential was determined from the change in energy of the ions with a change in charge, and the space distribution of the

potential was resolved from measurements of time of flight of particles through the volume of the plasma. (tr-auth)

**27721** (LA-UR-75-1411) INSTRUMENTATION FOR HIGH-ENERGY INFRARED LASER DIAGNOSTICS. Figueira, J. F. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-Eng-36. 7p. (CONF-750835-1). Dep. NTIS $4.00.

From Society of Photo-Optical Instrumentation Engineers Meeting; Palos Verdes Estates, California, USA (18 Aug 1975).

Infrared diagnostic techniques as applied to the laser fusion program are discussed. No attempt is made to make a complete infrared detector survey, but rather devices and systems that have satisfied the particular requirements of the fusion program are discussed and some of the limitations of these methods and directions for future development are indicated. (MOW)

**27722** (MATT-1085) MEASUREMENT OF THE DEVELOPMENT AND EVOLUTION OF SHOCK WAVES IN A LASER-INDUCED GAS BREAKDOWN PLASMA. Chu, T. K.; Johnson, L. C. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 28p. Dep. NTIS $4.50.

Space- and time-resolved interferometric measurements of electron density in $CO_2$-laser produced plasmas in helium or hydrogen are made near the laser focal spot. Immediately after breakdown, a rapidly growing region of approximately uniform plasma density appears at the focal spot. After a few tens of nanoseconds, shock waves are formed, propagating both transverse and parallel to the incident laser beam direction. Behind the transverse propagating shock is an on-axis density minimum, which results in laser-beam self trapping. The shock wave propagating toward the focusing lens effectively shields the interior plasma from the incident beam, because the lower plasma temperature and higher plasma density in the shock allow strong absorption of the incident beam energy. By arranging the laser radiation-plasma interaction to begin at a plasma-vacuum interface at the exit of a free-expansion jet, this backward propagating shock wave is eliminated, thus permitting efficient energy deposition in the plasma interior. (auth)

**27723** (N-74-28172) THEORETICAL AND EXPERIMENTAL INVESTIGATION OF CYLINDRICAL ELECTROSTATIC PROBES AT ARBITRARY INCIDENCE IN FLOWING PLASMA. Jenkins, R. V.; Jones, W. L. Jr. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Jul 1974. 42p. (NASA-TR-R-425). NTIS $3.25.

The theory for calculating the current collected by a negatively biased cylindrical electrostatic probe at an arbitrary angle of attack in a weakly ionized flowing plasma is presented. The theory was constructed by considering both random and directed motion simultaneous with dynamic coupling of the flow properties and of the electric field of the probe. This direct approach yielded a theory that is more general than static plasma theories modified to account for flow. Theoretical calculations are compared with experimental electrostatic probe data obtained in the free stream of an arc-heated hypersonic wind tunnel. The theoretical calculations are based on flow conditions and plasma electron densities measured by an independent microwave interferometer technique. In addition, the theory is compared with laboratory and satellite data previously published by other investigators. In each case the comparison gives good agreement. (auth)

**27724** (ORNL-tr-4012) MULTICHANNEL ANALYZER FOR ENERGY AND MASS SPECTRA OF ATOMIC PARTICLES. Afrimov, V. V.; Berezovskii, E. L.; Gladkovskii, I. P.; Kislyakov, A. I.; Petrov, M. P.; Sadovnikov, V. A. Translated by M. Gerrard from Zh. Tekh. Fiz.; 45: No. 1, 56-63(1975). 21p. Dep. NTIS $4.25.

A 5-channel analyzer, designed for studying atom and ion currents emitted by a hot plasma, is described. Analysis of atoms is based on their conversion to ions by stripping in the gas. For determining the parameters of the secondary ions, magneto-electric or binary electrical analysis is used, which makes it possible to obtain mass as well as energy spectrum data of particles. The analyzer is calibrated with beams of hydrogen and deuterium atoms in the energy range 200 to 10,000 eV. The calibration is made under conditions of single collisions of atoms with nitrogen molecules, the nitrogen being admitted to the stripping chamber in equilibrium state. However, in order to increase the sensitivity of the analyzer, it was calibrated with collisions of atoms with a thin gas target obtained by pulsed admission of helium to the stripping chamber. A 2.5- to 20-fold increase in sensitivity was recorded, depending on the energy of the atoms. Examples are given of the energy distribution of atoms, obtained with the analyzer on the Tokamak-4 equipment. (auth)

**27725** (ORO-4338-6) PROPAGATION OF ION ACOUSTIC WAVES IN A TWO-ELECTRON-TEMPERATURE PLASMA. Jones, W. D.; Lee, A.; Gleman, S. M.; Doucet, H. J. (University of South Florida, Tampa (USA). Dept. of Physics). 20 Aug 1975. Contract AT(40-1)-4338. 12p. Dep. NTIS $4.00.

The propagation of ion acoustic wave (IAW) in a double-electron-temperature plasma is investigated both experimentally and theoretically. It is found that the presence of even a small fraction of the lower-electron-temperature component can dominate the behavior of the waves. The results have important implications both for the use of IAW as a diagnostic tool for measuring electron temperature and for the interpretation of turbulent IAW spectra. (auth)

**27726** (UCID-16897) IMACON 600 ULTRAFAST STREAK CAMERA EVALUATION. Owen, T. C.; Coleman, L. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Sep 1975. Contract W-7405-Eng-48. 35p. Dep. NTIS $4.00.

The Imacon 600 has a number of designed in disadvantages for use as an ultrafast diagnostic instrument. The unit is physically large (approximately 5' long) and uses an external power supply rack for the image intensifier. Water cooling is required for the intensifier; it is quiet but not conducive to portability. There is no interlock on the cooling water. The camera does have several switch selectable sweep speeds. This is desirable if one is working with both slow and fast events. The camera can be run in a framing mode. (MOW)

**27727** (UCRL-51914) LASER LIGHT SCATTERING AND ABSORPTION IN DENSE, SPHERICALLY SYMMETRIC PLASMAS. Erkkila, J. H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1975. Contract W-7405-eng-48. 139p. Dep. NTIS $5.45.

Thesis.

A computational study of the interaction of a focused laser beam with a dense, spherically symmetric plasma is undertaken. The plasma is treated using linearized fluid equations for the electrons with the ions assumed immobile; the electromagnetic field is determined from steady state solutions to Maxwell's equations in spherical coordinates. Energy dissipation in the plasma occurs as a result of inverse bremsstrahlung collisions and resonance absorption. The scattered field distribution and the spatial variation of the fields and energy deposition within the plasma are found for various laser-plasma configurations and the applicability of the theory as a function of plasma temperature and laser power is determined with a self-consistent analysis. (auth)

**27728** MASS SPECTROMETER FOR PLASMA DIAGNOSTICS. Measurements of Ion Translational Temperature, Polarization, and Velocity Effects. Rowe, B. (Centre National de la Recherche Scientifique, 92 – Meudon-Bellevue (France)). Int. J. Mass Spectrom. Ion Phys.; 16: No. 3, 209-223(Mar 1975).

A quadrupole mass spectrometer with a retarding potential grid was studied as a diagnostic apparatus for ion kinetic energy distributions and, consequently, as a diagnostic apparatus for translational temperature, mass velocity and ionic concentrations. Arc plasma jets with a particle number density of $10^{21}$ $m^{-3}$, electron number density of $10^{18}$ $m^{-3}$, a mean velocity of $10^3$m $s^{-1}$ and a thermal energy of a fraction of an eV have been studied. Firstly a study is presented on focusing effects which depend on the sheath potential; it has been pointed out that the focusing effects on kinetic energy distribution are negligible and that the experimental signal of the mass spectrometer agrees with the theoretical curve. It has also been pointed out the mean velocity effect on the mass spectrometer signal. It is then described how the apparatus has been employed for measuring translational temperature variations and concentration variations in a hydrogen plasma. (auth)

**27729** MASS-SPECTROMETRIC MONITORING OF IONS IN PLASMAS AND SWARMS. Hasted, J. B. (Birkbeck Coll., London (UK)). Int. J. Mass Spectrom. Ion Phys.; 16: No. 1-2, 3-14(Jan 1975).

From 22nd annual conference on mass spectrometry and allied topics; Philadelphia, PA (21 May 1974).

An ion monitoring system consists of an orifice in a metal foil, an accelerating lens, a mass spectrometer and a detector. The purpose of the system is to produce an ion count which is proportional to the density of the ion species near the orifice, which is inserted into a plasma. Because this is difficult to verify experimentally, one must rely on an understanding of the theory of ion extraction through an orifice, of the ion optics, and of the mass spectrometer efficiency. These will be considered both in the electrical discharge regime and in the higher pressure flame regime. Design features of mass-spectrometric systems for sampling will also be considered. In the discharge plasma regime it is possible to operate in such a way that the ion count is proportional to the ion density, but the proportionality constant is not known accurately. The orifice plate is treated as a Lang-

muir probe and electron and ion currents to it can be calculated. Consideration must be given to the biasing of the orifice with respect to the plasma potential and to the role played by the plasma sheath in ion optics. Sampling of both positive and negative ions is considered. In the convective, or flame regime the dominant effect is one of cooling by expansion of the gas flowing through the orifice. Ion populations freeze at a temperature much lower than that of the flame, and collisions occur during the sampling process. Although the sampled ion populations are not characteristic of those existing in the flame, valuable information can still be obtained. (auth)

**27730** OPTICAL-ELECTRONIC TEMPERATURE MEASUREMENT IN PLASMA FLAMES WITH A XENON-HIGH PRESSURE LAMP USED AS A COMPARATIVE RADIATOR. Huster, R. (Muenster Univ. (F.R. Germany). Inst. fuer Physikalische Chemie). Ber. Bunsenges. Phys. Chem.; 79: No. 1, 94-97(1975). (In German).

3 figs.

It is shown that it is possible to measure continuously temperatures of plasma-flames up to 5,000°K by using a high-pressure xenon lamp as a comparison radiator. A method is developed for calibrating a regulatable comparison radiator absolutely by knowing only one point on its temperature curve exactly. (auth)

**27731** HIGH-FREQUENCY MODULATION OF ATOMIC PARTICLE BEAMS FOR PLASMA DIAGNOSTICS. Demchenko, P. A. (Physicotechnical Inst., Kharkov); Krupnik, L. I.; Leontovich, K. A.; Lyangner, E. S. Instrum. Exp. Tech.; 17: No. 6, 1574-1577(1974).

Translated from Prib. Tekh. Eksp.; No. 6, 26-29(1974).

A device is described which permits modulation of the intensity of atomic-particle beams with energies of $\sim 10^4$ eV at frequencies up to $\sim 2 \times 10^7$ Hz. A large aperture recording apparatus is described which permits measurement of modulated probe beams against a background of strong natural electromagnetic and corpuscular plasma radiation. (auth)

## Plasma Kinetics (General)

*Refer also to abstract 29014.*

**27732** (INR-1449/18/PP/C) REVIEW OF WORKS OF THE DEPARTMENT OF PLASMA PHYSICS AND TECHNOLOGY OF INR IN THE FIELD OF TECHNICAL APPLICATIONS OF LOW-TEMPERATURE PLASMA. Brzozowski, W. S.; Reda, J. (Institute of Nuclear Research, Warsaw (Poland)). 1973. 58p. (In Polish). INIS.

This paper includes a review of works of major importance which were carried out in the Department of Plasma Physics and Technology of INR in the period of the last ten years (1961–1971). In this article a description of devices and technologies in the field of technical applications of low-temperature plasma in Polish industry is also given. (auth)

**27733** MULTIPLE SCATTERING OF A FOCUSED BEAM OF MONOENERGETIC ELECTRONS. Vyalov, G. N. Sov. Phys.-Tech. Phys.; 19: No. 9, 1216-1218(Mar 1975).

Translated from Zh. Tekh. Fiz.; 44: No. 9, 1955-1960(Sep 1974).

The mean-square dimensions of an axisymmetric focused beam of monoenergetic electrons subject to multiple scattering are determined. The mean-square dimensions in a longitudinal magnetic field are calculated for arbitrary total scattering angles. The scattering of a magnetically self-focused charge-neutralized beam is also calculated. An approximate expression valid for small total scattering angles is obtained for the mean-square dimensions. The beam current is estimated by assuming that the beam propagates without significant change in the transverse dimension. The calculation is performed by determining the trajectory of a single electron, taking account of random forces, and then averaging over the trajectories. (auth)

**27734** SURFACE DENSITY OF ACCUMULATED ELECTRONS ON WALLS IN CONTACT WITH A PLASMA. De, B. R. (California Univ., La Jolla, San Diego (USA). Dept. of Applied Physics and Information Science). Astrophys. Space Sci.; 35: No. 1, L17-L19(Jun 1975).

It is shown that the surface density of accumulated electrons on a wall in contact with a plasma can be expressed as a simple function of the Debye shielding distance in the plasma. The result may have applications to problems involving objects immersed in a space plasma. (auth)

**27735** PLASMA FLOW IN A CONVERGING AND DIVERGING CONFIGURATION AND THE ASSOCIATED PLASMA PARTICLE ACCELERATION: KINETIC APPROACH. Fridman, M. (Univ., Liege). J. Plasma Phys.; 13: 481-497(Jun 1975).

Transport laws in collisionless systems must be derived from the one-particle Liouville equation. The simplest cases are those of the CGL invariants along the magnetic field lines, together with the resulting equations of continuity and motion, in circumstances where a supersonic particle flux is parallel to a diminishing magnetic field. Functional expressions are given for the two contributions to the parallel heat flux, with integrated forms of kinetic theory. The general expressions, corresponding to the moments of greater order, coincide with those obtained by series development of the differential equation of moments. Moreover, a case of both parallel and convergent flux is illustrated, for which the equation of continuity gives considerable acceleration to the precipitation flux average velocity in the absence of any important electric field, because that acceleration is important in understanding the relationship between the plasmasheet and the ionosphere. (auth)

**27736** INTERACTION OF POTENTIAL OSCILLATIONS IN MAGNETOACTIVE PLASMA. Sturman, B. I. (Novosibirsk State Univ., USSR). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 17: No. 12, 1765-1774(1974). (In Russian).

A simplified dynamic description of the nonlinear interaction of potential oscillations in a magnetoactive plasma is considered. The instability of a potential large-amplitude wave is investigated. (auth)

## Plasma Kinetics (Experimental)

**27737** (MATT-1077) RADIATION FROM PLASMAS IN THE ST TOKAMAK. Bretz, N.; Dimock, D.; Greenberger, A.; Hinnov, E.; Meservey, E.; Stodiek, W.; Von Goeller, S. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Oct 1974. Contract A(11-1)-3073. 10p. (IAEA-CN-33/A3-1). Dep. NTIS $4.00.

Quantitative vacuum ultraviolet (UV) measurements (lambda greater than or equal to 100 A) of various ST Tokamak discharges show that the atom density of metal impurities is about 0.1 percent to 1.5 percent of electron density and that the atom density of oxygen is about 1 percent to 10 percent. These concentrations yield an effective ionic charge, $\bar{Z}$, consistent with the measured current, voltage, and profiles of electron temperature. The radial distribution of high-Z material is obtained from x-ray measurements in the range 1 less than or equal to lambda less than or equal to 4 A; from these we conclude that there is no extreme concentration of high-Z material in the center, but cannot exclude variations within a factor of 2. The x-ray spectrum is dominated by recombination; using bremsstrahlung and recombination calculations the value of $\bar{Z}$ derived from x-ray intensity is comparable with the value from conductivity. An instrument is described for making measurements in the extreme UV region (5 less than lambda less than 20 A). In this range strong emission has been observed (radiated power about 10 percent of power input in the center), which we attribute to line emission from heavy metal (Fe or Mo) ions which are produced only at electron temperature above about 1200 eV; the very narrow radial profile of observed intensity is consistent with measured temperature and density profiles. Rough estimates of the concentration of heavy metals required to account for the radiated power are consistent with vacuum UV and x-ray data. (auth)

**27738** (N-75-12775) PULSED ELECTROMAGNETIC GAS ACCELERATION. Semiannual Report, 1 January–30 June 1974. Jahn, R. G.; VonJaskowsky, W.; Clark, K. E. (Princeton Univ., N. J. (USA). Guggenheim Labs. for the Aerospace Propulsion Sciences). Jul 1974. 127p. (NASA-CR-140996; SAR-634w). NTIS $5.75.

Detailed measurements of the axial velocity profile and electromagnetic structure of a high power, quasi-steady MPD discharge are used to formulate a gasdynamic model of the acceleration process. Conceptually dividing the accelerated plasma into an inner flow and an outer flow, it is found that more than two-thirds of the total power in the plasma is deposited in the inner flow, accelerating it to an exhaust velocity of 12.5 km/sec. The outer flow, which is accelerated to a velocity of only 6.2 km/sec, appears to provide a current conduction path between the inner flow and the anode. Related cathode studies have shown that the critical current for the onset of terminal voltage fluctuations, which was recently shown to be a function of the cathode area, appears to reach an asymptote for cathodes of very large surface area. Detailed floating potential measurements show that the fluctuations are confined to the vicinity of the cathode and hence reflect a cathode emission process rather than a fundamental limit on MPD performance. (auth)

**27739** (ORNL-TM-5054) NEUTRON EMISSION FROM ORMAK. Berry, L. A.; England, A. C.; Lyon, J. F.; Morgan, G. L. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-Eng-26. 30p. Dep. NTIS $4.00.

Neutron rates from deuterium beam injection into a deuterium plasma were studied in ORMAK. The absolute rates as well as the ratio of co- to counterinjection-produced neutrons are in agreement with a simple theory. This theory takes into account the electric field and electron temperature but neglects loss regions, deuteron deficiency, trapping efficiencies, and energy diffusion. The neutron energies were measured with an organic scintillator. The 2.45-MeV group from the primary d-d reaction is evident and another group at approximately 1 MeV apparently from inelastic collisions in aluminum is observed. There is disagreement between the relative neutron rates and the expected rates of neutrons from the injection calculated on the basis of charge-exchange measurements. Further calculations are expected to resolve this discrepancy. (auth)

**27740** (ORO-4514-2) PRODUCTION AND ANALYSIS OF THERMONUCLEAR PLASMAS IN HIGH BETA DEVICES. Progress Report. DeSilva, A. W.; Griem, H. R.; Chen, Y. G.; Goldenbaum, G. C. (Maryland Univ., Baltimore (USA)). Jul 1975. 10p. Dep. NTIS $4.00.

Summaries of research work during this period are given for the following topics: (1) toroidal systems, (2) measurements in open systems, (3) ion dynamics and heating in a small theta pinch, (4) tunable laser diagnostics, and (5) electron energy and density measurements. (MOW)

## Plasma Kinetics (Theoretical)

**27741** (MATT-1076) THEORY AND NUMERICAL SIMULATION OF COLLECTIVE TRANSPORT OF PLASMA IN MAGNETIC FIELDS. Canosa, J.; Krommes, J.; Oberman, C.; Okuda, H.; Tsang, K.; Dawson, J. M.; Kamimura, T. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Oct 1974. Contract A(11-1)-3073. 14p. (IAEA-CN-33/H2). Dep. NTIS $4.00.

Numerical and theoretical studies were made on the transport of particles and heat in collisionless plasmas in magnetic fields for both quiescent and turbulent states. The following problems have been investigated: (1) A systematic kinetic theory of hydrodynamic fluctuations in a strong magnetic field was developed to study the particle diffusion due to thermal convective cells. (2) Effects of density and temperature gradients on thermal convective cells; they are found to destabilize both the ion flute and the convective cells. (3) Effects of mirroring magnetic field on convective diffusion; they are found to increase the diffusion significantly even for open field lines of force. (4) Turbulent electron heat transfer due to short wavelength ion fluctuations near the lower hybrid frequency; this may be important in a collisionless plasma. (5) Heat transfer due to emission and absorption of electrostatic plasma waves are studied theoretically and by simulation; agreement has been found for a strong magnetic field case. (6) Particle diffusion in a toroidal magnetic field due to collisions (neo-classical diffusion) and due to collective effects is studied by numerical simulations. Neoclassical theory agrees well with the numerical results when the long wavelength collective modes are suppressed. (auth)

**27742** (MATT-1078) TRANSPORT AND DIVERTOR STUDIES IN THE FM-1 SPHERATOR. Ando, K.; Ejima, S.; Davis, S.; Hawryluk, R.; Hsuan, H.; Meade, D.; Okabayaski, M.; Sauthoff, N.; Schmidt, J.; Sinnis, J. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Oct 1974. Contract AT(11-1)-3073. 15p. (IAEA-CN-33/B4-4). Dep. NTIS $4.00.

Fundamental problems of toroidal fusion devices have been investigated in the FM-1 Spherator. These subjects include the transport due to drift wave turbulence in the trapped electron regime, poloidal divertor and impurities, and lower hybrid heating. (auth)

**27743** (MATT-1093) THEORY OF PLASMA SIMULATION USING THE MULTIPOLE-EXPANSION SCHEME. Chen, L.; Okuda, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 28p. Dep. NTIS $4.50.

Nonphysical grid effects in plasma simulation using the Multipole-Expansion scheme and Gaussian-shape charge particles are studied analytically in one dimension. General expressions for the linear dispersion relation, fluctuation spectra, energy, and momentum conservations are derived and then compared with those of the Cloud-in-Cell (CIC) scheme. The results indicate that the Dipole-Expansion scheme and its subtracted version have, in general, grid effects comparable to CIC. Grid effects are, however, greatly reduced in schemes keeping higher order moments, such as the Quadrupole-Expansion scheme. (auth)

**27744** (MATT-1099) NUMERICAL STUDY OF THE MAGNETOHYDRODYNAMIC SPECTRA IN TOKAMAKS USING GALERKIN'S METHOD. Dewar, R. L.; Greene, J. M.; Grimm, R. C.; Johnson, J. L. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 43p. Dep. NTIS $5.25.

A computational technique is described for determining the ideal magnetohydrodynamic spectrum and its associated eigenfunctions. The method is suitable for axisymmetric toroidally confined plasmas with arbitrary cross sections. Using the special case of a long, straight, elliptical plasma column with low pressure and uniform axial current where analytic results are available, a study is made of the efficacy of two different choices of expansion functions. The use of a finite-element representation, keeping only a small number of terms, is shown to provide a good description of the system. (auth)

**27745** (SAI-75-636-LJ) ONE DIMENSIONAL FLUID NUMERICAL ANALYSIS. Final Report. Byrne, R. N.; Engebretson, A.; Hamasaki, S.; Klein, H. H.; Krall, N. A.; Mc Bride, J. B.; Sturat, G. W.; Sulton, A. L.; Tamor, S.; Wagner, C. E. (Science Applications, Inc., La Jolla, Calif. (USA)). Aug 1975. Contract AT(04-3)-1018. 395p. Dep. NTIS $22.75.

A one-dimensional plasma transport code G1M was developed and applied to the problem of determining the effect of microinstabilities on Tokamak startup, a zero-dimensional code was developed and used to study TCT equilibria, and a preliminary version of a two-dimensional synchrotron radiation transport code SNECTR was developed and used to estimate the importance of this radiation as an energy transport mechanism. This work was broadened to include a survey of ELMO Bumpy Torus, the development of a two-dimensional Tokamak transport code, G2M, and a particle-ion fluid-electron capability in G1M, resulting in the theta-pinch version HYBRID. In addition, research was initiated on a new technique for particle simulation codes and on the source of the striations observed in theta pinch experiments. (MOW)

**27746** (UCID-16917) RECENT ADIABATICITY RESULTS FROM ORBIT CALCULATIONS. Foote, J. H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1975. Contract W-7405-eng-48. 35p. Dep. NTIS $4.00.

There has been much activity recently in an attempt to find a straightforward method of predicting the limits of adiabatic behavior in high-beta magnetic-mirror configurations. The particle-orbit code TIBRO was used to obtain numerical results on non-adiabatic behavior with which the predictions of theoretical expressions can be compared. These results are summarized. (MOW)

**27747** (UCRL-77211) COMPUTATIONAL PLASMA PHYSICS. Killeen, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1975. 63p. (CONF-750865-1). Dep. NTIS $6.25.

From 3rd national computational physics conference on partial differential equations in physics; Glasgow, UK (27 Aug 1975).

The behavior of a plasma confined by a magnetic field is simulated by a variety of numerical models. Some models used on a short time scale give detailed knowledge of the plasma on a microscopic scale, while other models used on much longer time scales compute macroscopic properties of the plasma dynamics. In the last two years there has been a substantial increase in the numerical modelling of fusion devices. The status of MHD, transport, equilibrium, stability, Vlasov, Fokker-Planck, and Hybrid codes is reviewed. These codes have already been essential in the design and understanding of low and high beta toroidal experiments and mirror systems. The design of the next generation of fusion test reactors will require continual development of these numerical models in order to include the best available plasma physics description and also to increase the geometric complexity of the model. (auth)

**27748** RE-NORMALIZED QUASI-LINEAR APPROXIMATION OF PLASMA TURBULENCE. I. Modification of the Weinstock Weak-coupling Limit. Misguich, J. H. (CEN, Fontenay-aux-Roses, France); Balescu, R. J. Plasma Phys.; 13: 385-417(Jun 1975).

A renormalized expansion is presented for the solution of the fluctuating Vlasov equation for turbulent plasmas. Its first term can be identified with the Weinstock (Weinstock, J., 1969 Phys. Fluids, 12, 1045, 1970 Phys. Fluids, 13, 2308) result in the weak-coupling approximation. The use of time-ordering operators allows one to solve the Weinstock $U_A$ evolution operator explicitly. Detailed results are given for the weak-coupling approximation, presented here as a simple renormalization of the quasi-linear theory. Results of Weinstock and Birmingham & Bornatici (Birmingham, T. J. & Bornatici, M., 1972, Phys. Fluids, 15,

1778, 1785), concerning the frequency shift, resonance broadening and Dupree damping appear to be deeply modified by similar corrective terms. These arise from a consistent handling of expressions involving non-commuting operators. (auth)

**27749** RE-NORMALIZED QUASI-LINEAR APPROXIMATION OF PLASMA TURBULENCE. II. Validity of Short-time Expansion and Markovian Truncation of the Propagator. Misguich, J. H. (CEN, Fontenay-aux-Roses, France); Balescu, R. J. Plasma Phys.; 13: 419-427(Jun 1975).

In part 1 (Misguich, J. H. & Balescu, R., 1975 J. Plasma Phys. 13, 385) the Dupree description of plasma turbulence (i.e. the weak-coupling approximation of Weinstock (Weinstock, J. 1969 Phys. Fluids, 13, 1045)) was derived and completed in the framework of the renormalized quasilinear approximation. The time behavior of the frequency shift and of the Dupree damping was proved to be modified by time-ordering effects, usually neglected. In part 2 it is shown that a Markovian truncation must be applied to the basic average propagator $\bar{U}$, to recover the short-time expansion of Birmingham & Bornatici, (Birmingham, T. J. & Bornatici, M., 1972, Phys. Fluids. 15, 1778, 1785). Such an expansion is shown to be generally nonconvergent. The corresponding short-time results are invalid. (auth)

**27750** NEW PERTURBATION THEORY OF RANDOM ACCELERATION AND FORMALLY SIMILAR PROBLEMS. Cook, I. (Culham Lab., Abingdon, Eng.). Plasma Phys.; 17: No. 7-8, 629-632(Jul 1975).

It is shown how an equation, due to Orszag and Kraichnan (Orszag, S. A. and Kraichnan, R. H. (1967) Physics Fluids, 10, 1720) satisfied by the average of the solution of a linear random equation may be obtained very straightforwardly from an improved perturbation theory. This equation is the first member of a sequence of conditions, the imposition of which optimizes the convergence properties of the expansion. (auth)

**27751** ENERGY TRANSFER BETWEEN ELECTRONS AND IONS IN A STATIONARY PLASMA WITH HIGH IONIZATION FACTOR. van der Sijde, B.; Dielis, J.; Pots, B.; Schram, D. C. (Technische Hogeschool Twente, Enschede (Netherlands). Afdeling Technische Natuurkunde). Ned. Tijdschr. Natuurkd.; 41: No. 9, 106-108(3 May 1975). (In Dutch).

Median conditions for an argon plasma in a magnetic field are defined and identified, electron and ion temperatures being 30 and 10,000 deg. K. respectively. Classical theoretical equations are developed for energy transfer for both ions and electrons in terms of temperatures, densities and the so-called Coulomb logarithm. A fraction "f" is defined as a ratio of ionic and transfer energies to the ionic energy, and values of this fraction obtained experimentally are plotted against the current strength over the range 20-125 A. Plasma stability characteristics are investigated by reference to the linear Vlasov theory and a plot of the ratio drift/thermal velocity to electron/ion temperature over ranges 0.01 to 0.10 and 2 to 20 respectively. (auth)

**27752** INFLUENCE OF DEVIATIONS FROM THE MAXWELLIAN ELECTRON DISTRIBUTION ON THE POPULATION DENSITIES IN A LOW TEMPERATURE MONATOMIC PLASMA. Claassen, H. A. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Plasmaphysik). Z. Naturforsch., A; 30: No. 4, 451-460(Apr 1975).

4 figs.; 1 tab.; 28 refs.

A self-consistent solution with respect to both free and bound electron energy states is presented for a low temperature monatomic plasma. The deviations from a Maxwellian electron distribution under the action of unbalanced resonance transitions of the plasma atoms are incorporated in analytical form using a recursion formula, which links the high energy tail of the electron distribution function to its low energy part. The unbalance of the resonance level may be due to diffusion processes and/or radiation escape, which reflect the influence of the plasma boundaries. The population densities of the bound electron energy states are numerically determined by an iteration procedure. The calculations were performed for a cesium plasma both without and with consideration of resonance level diffusion and ambipolar diffusion. As is to be expected, the effect of a disturbance of the electron distribution on the population densities increases with decreasing electron density and increasing electron temperature. (GE)

**27753** PLASMA FREQUENCY IN A LAYERED ELECTRON GAS. Corciovei, A.; Apostol, M. (Institutul de Fizica Atomica, Bucharest (Romania)). Phys. Lett., A; 53: No. 4, 345-346(30 Jun 1975).

The equation-of-motion method is applied in the RPA for an electron-hole pair operator in the layered electron gas of Visscher and Falicov. The band of plasma frequencies is obtained at zero temperature. (auth)

**27754** DERIVATION OF RELATIVISTIC KINETIC EQUATIONS IN STRONG ELECTROMAGNETIC FIELD. Prozorkevich, A. V.; Smolyanskii, S. A. (Saratov State Univ., USSR). Teor. Mat. Fiz.; 23: No. 3, 409-417(Jun 1975). (In Russian).

In the framework of D. N. Zubarev's nonequilibrium statistical operator method, relativistic kinetic equation for a classical completely ionized small density plasma in strong rapidly changing electromagnetic field is deduced for the first time. In the particular case, when all the effects of external fields on the particle collision process are neglected, the collision integral obtained in the present work is transformed to the Landau relativistic collision integral obtained previously by other methods. (auth)

**27755** EXCITATION AND DISSIPATION OF Pc-1 MICROPULSATIONS. Hung, R. J. (Univ. of Alabama, Huntsville); Smith, R. E. pp 351-362 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A theoretical model based on hydromagnetic instabilities (including Alfven firehose and magnetoacoustic mirror instabilities), in the region where the electrons are in the transition from collisional to collisionless and ions are in the collisionless region, is proposed as a possible wave emission mechanism for Pc-1 pulsations. The model is compared with recent observations with good agreement between the theory and observations, especially for an emission source located at a distance L less than 5. Furthermore, a suggestion is made that the hydromagnetic instabilities could be relevant to the night and early morning hours emissions while the ion cyclotron instabilities could be responsible for the daytime emission of Pc-1 pulsations. (auth)

**27756** KINETIC EQUATIONS FOR A PLASMA SUBMITTED TO AN EXTERNAL TIME-DEPENDENT ELECTRIC FIELD. Di Bona, G.; Masselot, C. (CEA Centre d'Etudes de Limeil, 94- Villeneuve-Saint-Georges(France)). Physica; 79: No. 3, 259-275(1975). (In French).

The Stratonovich-So-Ogunlana stochastic method is applied in a systematic way to the study of a plasma submitted to a time-dependent external field. According to the approximations used, it is found generalisations of the Vlasov, Landau-Fokker-Planck and Balescu-Lenard equations for the case of a plasma in an external time-dependent field. (auth)

**27757** STOCHASTIC TURBULENCE IN VLASOV PLASMAS. Misguich, J. H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee); Balescu, R. (Brussels Univ. (Belgium). Faculte des Sciences). Physica; 79: No. 4, 373-401(1975).

A general stochastic treatment is performed from the fluctuating Vlasov equation describing an ensemble of collisionless turbulent plasmas. The general result consists in an apparently markovian form of the Weinstock equation. This equation clearly exhibits the role of turbulent collisions and ballistic term associated with the propagation of the initial fluctuation. As a particular case, one recovers of course the quasilinear (QL) description. By using a renormalized expansion for the Weinstock propagator, one recovers as a first term the Dupree-Weinstock weak-coupling description whick appears here as a renormalized quasilinear approximation (RQL). Explicit results are derived in this RQL approximation by using a useful interaction representation for the propagators. Another approach is used in order to study the validity of the asymptotic approximation which is usually applied. This method is based on the existence of two subdynamics, i.e., of two independent equations describing the evolution of two complementary projections of the distribution function. (auth)

## Plasma Production

*Refer also to abstract 28788.*

**27758** (IPP-4/129) EXPANSION OF POLYETHYLENE PELLETS IRRADIATED BY A NEODYMIUM LASER. Ariga, S.; Buechl, K.; Haering, T. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Jan 1975. 18p. Dep. NTIS (US Sales Only) $4.00.

The expansion of polyethylene pellets (200 $\mu$ diameter) after irradiation by a Nd laser pulse was investigated by shadowgram diagnostics. Only a small part of the pellet is converted into hot plasma. For short pulses (5 nsec) the rest of the pellet explodes mainly into small pieces of solid matter. For long pulses (50 nsec) a part of the pellet becomes a dense gas or cold plasma. With increasing pulse energy the portion of solid pieces decreases and the portion of cold plasma increases. These results suggest a pre-pulse method for plasma production from pellets. (auth)

**27759** (LA-UR-75-1573) LASER-PLASMA INTERACTION IN THE SCYLLA I-C THETA PINCH. McKenna, K. F.; Zimmermann, E. L.; Freese, K. B. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944-4). Dep. NTIS $4.00.

From 3rd topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The concept of heating high density magnetically confined plasmas with long wavelength laser light is of considerable interest for fusion applications. The Scylla I-C experiment was initiated in order to investigate the interaction of a high power (approximately $10^9$ W) $CO_2$ laser beam with a dense (n/sub e/ greater than or equal to $10^{17}$ $cm^{-3}$) theta-pinch plasma. The experiment is directed toward the investigation of (a) channeling of the laser beam along the large aspect ratio (L/D approximately 100) plasma column, (b) plasma heating by laser energy absorption, and (c) anomalous backscatter of laser light. The results of an investigation of the theta-pinch plasma parameters, the $CO_2$ laser operating characteristics, and the phenomenology of the laser-plasma interaction are discussed. (auth)

**27760** (UCID-16892) DESIGN OF A LARGE DIAMETER PLASMA FOCUS INSULATOR. Gullickson, R. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Sep 1975. Contract W-7405-Eng-48. 27p. Dep. NTIS $4.00.

Various concepts were considered to provide an insulator for the one meter diameter Filippov geometry, 1 megajoule plasma focus device. Among these are the idea of coating a metal cylinder with a ceramic using a plasma spraying technique, and the idea of bonding together ceramic segments over a plastic base. Results of insulator tests are described. (MOW)

**27761** (UCRL-Trans-10890) COMPUTER EXPERIMENTS IN PHYSICS. Samarskii, A. A.; Popov, Y. P. Jul 1975. Translated from pp 281-291 and Table of Contents of International Yearbook on Major Developments in World Science, Izdatel'stvo "Znanie," Moscow, 1975. 32p. Dep. NTIS $4.75.

After a lengthy introduction on the history of scientific research and mathematics, the importance of electronic computers and the "computer experiment" is considered. To demonstrate the indispensability of the computer experiment in solving important physical problems, a discussion is presented on laser-induced fusion. (3 figures) (RWR)

**27762** THERMAL CONDUCTION IN LASER FUSION. Brysk, H.; Campbell, P. M.; Hammerling, P. (KMS Fusion, Inc., Ann Arbor, MI). Plasma Phys.; 17: No. 6, 473-484(Jun 1975).

The treatment of thermal conduction in the context of laser-driven fusion is examined critically. Expressions are given for electron and ion conductivity and for electron-ion equilibration after a discussion of the applicability of pre-existent formulations, supplemented by some new analysis, to the relevant density-temperature regime which includes Fermi degeneracy (with some judicious interpolation where the theories fail). The sensitivity of the fusion calculations to these considerations is illustrated by comparing the history of a typical laser-pellet interaction computed with the present coefficients and with the classical Spitzer set. (auth)

**27763** SPECTRUM OF X-RAY EMISSION FROM NSEC $CO_2$-LASER PRODUCED $(CH_2)_n$ AND Al PLASMAS. Pepin, H.; Baldis, H. A. (Quebec Univ., Varennes (Canada). Energy Research Centre). Phys. Lett., A; 53: No. 6, 493-494(28 Jul 1975).

Studies of the X-ray emission from nsec $CO_2$ laser produced plasmas indicate a stronger deviation of the electron distribution from equilibrium for a $(CH_2)_n$ plasma than for an Al plasma. The lowest spectral temperature measured is ~300 eV at the maximum flux of $5 \times 10^{12}$ W · $cm^{-2}$. (auth)

## Plasma Stability

**27764** (CONF-730750-, pp N1-N22) PLASMA INSTABILITIES DRIVEN BY ELECTRIC CURRENTS PERPENDICULAR TO A MAGNETIC FIELD. Hellberg, M. A.; Bharuthram, R. (Univ. of Natal, Durban, S. Afr.). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

The major features of the linear theory of electrostatic instabilities arising from currents flowing across a magnetic field are described. The uniform plasma situation was emphasized and the role played by Bernstein mode, ion acoustic waves, streaming instabilities, and resonant particles pointed out. In addition, the effects of nonuniformities were discussed. The nonlinear behavior was also discussed. (MOW)

**27765** (IPP-6/134) MAGNETOHYDRODYNAMIC INSTABILITIES FOR TOKAMAKS WITH NONCIRCULAR CROSS SECTION. Kerner, W. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Mar 1975. 71p. Dep. NTIS (US Sales Only) $6.75.

Stability is investigated by means of the energy principle. Suitable test functions are used to detect unstable perturbations and to determine the respective growth rates. The calculation involves no approximations, and so all parameters of the equilibrium solution can be arbitrarily varied. In this method only the stability limit is undetermined. With a free plasma boundary instabilities occur below and above the Kruskal-Shafranov limit for every aspect ratio investigated (e.i., $\epsilon^{-1} > 5$). Equilibria with highly elliptic cross sections generally involve more instabilities than those with circular cross sections. In order to attain a high degree of accuracy, extensive algebraic calculations are done by computer using the REDUCE programming language. (auth)

**27766** (LA-UR-75-1507) STABILITY ANALYSIS OF SHARP-BOUNDARY VLASOV-FLUID SCREW-PINCH EQUILIBRIA. Lewis, H. R.; Turner, L. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944-6). Dep. NTIS $4.00.

From 3rd topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Vlasov-fluid model is being used to study the linear stability of sharp-boundary screw pinches numerically. The numerical method appears to work well, and some preliminary results are reported. The sharp-boundary calculation is useful for gaining insight and for comparing with known MHD results. (auth)

**27767** (LA-UR-75-1667) REVIEW OF TOROIDAL THETA-PINCH THEORY. Davidson, R. C.; Freidberg, J. P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 25p. (CONF-750944-14). Dep. NTIS $4.25.

From 3rd topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A review is given of the basic theoretical ideas which describe the evolution of the Scyllac program. Included is a current status report of MHD and microstability theory as applied to the Scyllac configuration. (auth)

**27768** (MATT-1069) PHYSICAL MECHANISM OF PARAMETRIC INSTABILITIES NEAR THE LOWER-HYBRID FREQUENCY IN INHOMOGENEOUS PLASMA. Porkolab, M. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Oct 1974. Contract AT(11-1)-3073. 34p. Dep. NTIS $4.75.

The dispersion relation for parametric instabilities near the lower-hybrid frequency is obtained from model fluid equations. The following instabilities are discussed: for rf pump frequencies omega$_0$ greater than or equal to 3omega/sub LH/, omega/sub pe/ approximately equal to OMEGA/sub e/, resonant decay into ion sound (ion cyclotron) modes (previously predicted) is found. In the regime of 1 less than or equal to omega$_0$/omega/sub LH/ less than or equal to 3, omega/sub pe/ approximately equal to OMEGA/sub e/, decay into ion quasi-modes is found. In strong magnetic fields decay into quasi-modes is also found for 3 less than or equal to omega$_0$/omega/sub LH/. This mechanism is similar to nonlinear Landau damping in weak turbulence theory. In addition, decay into the purely growing mode and fluid-quasi modes may also occur. The results are compared with recent calculations from the Vlasov equation. The effects of plasma-inhomogeneities are considered, including effective thresholds due to density gradients and finite pump extent. The implications of these results to rf heating of tokamaks near the lower-hybrid frequency are discussed. (auth)

**27769** (MATT-1075) STABILITY THEORY OF DISSIPATIVE TRAPPED-ELECTRON AND TRAPPED-ION MODES. Horton, W. Jr.; Ross, D. W.; Tang, W. M.; Berk, H. L.; Frieman, E. A.; Laquey, R. E.; Lovelace, R. V.; Mahajan, S. M.; Rosenbluth, M. N.; Rutherford, P. H. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Nov 1974. Contract A(11-1)-3073. 9p. (IAEA-CN-33/A14-3). Dep. NTIS $4.00.

This paper treats topics in the linear theory of dissipative trapped-electron instabilities, and in the nonlinear theory of the dissipative trapped-ion instabilities. Stability criteria are obtained for dissipative trapped-electron modes in a tokamak-type magnetic field with shear. In the important case where the mode is driven by the electron temperature gradient, and neglecting "ballooning" effects, shear is found to stabilize the mode if typically r/sub n// L/sub s/ greater than 0.1 (r/2R)/sup 1/2/dlnT/sub e//dlnn, a condition that can be attained. With weak shear, it is shown, however, that the mode-structure along the field can exhibit substantial "ballooning." The dissipative trapped-ion mode, which is not shear-stabilized, is considered in its nonlinear regime. Including nonlinear E x B motions, exact stationary trapped-ion-mode solitary-wave solutions are found, in which the wave energy in longer

azimuthal wavelengths passes to shorter-wavelength components that are strongly damped by ion bounce resonances; the amplitudes are sufficiently reduced that a diffusion lower than Kadomtsev's is indicated. As a second nonlinear mechanism, anomalous velocity-space scattering due to the development of an unstable loss-cone-type ion distribution function is considered; this mechanism raises the effective ion collision frequency and increases the stability of the longer azimuthal-wavelength modes. (auth)

**27770** (MATT-1095) STUDY OF MAGNETOHYDRODYNAMIC MODES IN TOKAMAK CONFIGURATIONS WITH NONCIRCULAR CROSS SECTIONS. Chance, M. S.; Dewar, R. L.; Glasser, A. H.; Greene, J. M.; Grimm, R. C.; Jardin, S. C.; Johnson, J. L.; Rosen, B.; Sheffield, G. V.; Weimer, K. E. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1974. Contract AT(11-1)-3073. 14p. (IAEA-CN-33/A12-4). Dep. NTIS $4.00.

Stability criteria for localized instabilities for both ideal and resistive models are derived and evaluated for general axisymmetric configurations. A numerical scheme for determining the spectrum in these configurations is developed. Application is made to the special case of an elliptical cylindrical plasma column, with finite pressure and length, carrying a uniform axial current. (auth)

**27771** (MATT-1096) NONLINEAR SATURATION OF THE TRAPPED-ION MODE. LaQuey, R. E.; Mahajan, S. M.; Rutherford, P. H.; Tang, W. M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 14p. Dep. NTIS $4.00.

A nonlinear model of the collisional trapped-ion mode in tokamak geometry is presented, in which the energy in long wavelength instabilities is transferred to short wavelength modes which are then damped by ion bounce resonances. Near marginal stability, the saturation of a single unstable Fourier mode is computed. Far from marginal stability, steady state nonlinear solitary waves containing many Fourier modes are found. Particle transport is computed in both cases. (auth)

**27772** (MATT-1097) DEFEAT OF SHEAR STABILIZATION BY PEAKING OF THE DIAMAGNETIC FREQUENCY PROFILE. Sauthoff, N. R.; Okabayashi, M.; Schmidt, J. A. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 7p. Dep. NTIS $4.00.

The radial wave equation describing collisionless drift instabilities in plasma is solved including the effects of a peaked diamagnetic frequency profile. Radially localized fluctuations with no radial energy propagation are found in cases with sufficiently low shear and large peaking. (auth)

**27773** (MATT-1101) NUMERICAL STUDIES OF NONLINEAR EVOLUTION OF KINK AND TEARING MODES IN TOKAMAKS. White, R.; Monticello, D.; Rosenbluth, M. N.; Strauss, H.; Kadomtsev, B. B. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 11p. Dep. NTIS $4.00.

A set of numerical techniques for investigating the full nonlinear unstable behavior of low beta kink modes of given helical symmetry in Tokamaks is presented. Uniform current density plasmas display complicated deformations including the formation of large vacuum bubbles provided that the safety factor q is sufficiently close to integral. Fairly large m equals 1 deformations, but not bubble formation, persist for a plasma with a parabolic current density profile (and hence shear). Deformations for m greater than or equal to 2 are, however, greatly suppressed. (auth)

**27774** (MATT-1103) FILAMENTATION INSTABILITY IN AN INHOMOGENEOUS PLASMA. White, R.; Kaw, P. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 12p. Dep. NTIS $4.00.

Near forward scattering of electromagnetic radiation from ion acoustic waves in the presence of a density gradient is studied. Two absolutely unstable modes are found, neither of which is suppressed by the density gradient. (auth)

**27775** (N-74-30159/9ST) PARAMETRIC INSTABILITIES OF ORDINARY AND HYBRID WAVES. Hung, N. T. (Ecole Polytechnique Federale, Lausanne (Switzerland)). May 1974. 19p. (LRP-80/74). NTIS $4.00.

Coupled equations for ordinary and hybrid waves, propagating perpendicular to a static magnetic field, are derived within the fluid approximation. It is shown that a large amplitude ordinary wave is subject to a decay instability as well as a modulational instability. The latter corresponds to a modulation of the pump amplitude, and the excitation of a long wave length hybrid wave. Characteristic quantities, such as the threshold intensity and the maximum growth rate, are calculated for various cases. In the limit of a vanishing magnetic field, the results for stimulated Raman and Brillouin scattering are recovered. (auth)

**27776** (N-75-16352) ELECTROMAGNETIC INTERCHANGE MODE IN A PARTIALLY IONIZED COLLISIONAL PLASMA. Hudson, M. K.; Kennel, C. F. (Army War Coll., Carlisle Barracks, Pa. (USA)). Dec 1974. 40p. (NASA-CR-142017; PPG-201). NTIS $3.75.

A collisional electromagnetic dispersion relation is derived from two-fluid theory for the interchange mode coupled to the Alfven, acoustic, drift and entropy modes in a partially ionized plasma. The fundamental electromagnetic nature of the interchange model is noted; coupling to the intermediate Alfven mode is strongly stabilizing for finite k sub z. Both ion viscous and ion-neutral stabilization are included, and it was found that collisions destroy the ion finite Larmor radius cutoff at short perpendicular wavelengths. (auth)

**27777** INSTABILITY CAUSED BY DISSIPATION IN PLASMAS CARRYING NEGATIVE ENERGY WAVES. Pecseli, H. L. (Danish Atomic Energy Commission, Risoe). Plasma Phys.; 17: No. 6, 493-497(Jun 1975).

In the well known simplified picture of Landau damping it is expected that longitudinal plasma oscillations with phase velocity Vp would be damped when there are more particles with velocities slightly below Vp than there are particles with velocities slightly above. A wave with plasma velocity (v) + W would be damped while a wave with phase velocity (v) - W should grow according to the above argument. On the other hand single humped displaced velocity distributions are known to be stable. This apparent inconsistency is remedied by realising that the slow wave has a negative energy in the stationary frame of reference, thus even though the wave gains energy from the resonant particles it loses negative energy and hence damps out. Conversely the introduction of dissipation in the medium may cause the wave to grow. (UK)

**27778** PARAMETRIC INSTABILITIES OF ORDINARY AND HYBRID WAVES. Hung, N. T. (Ecole Polytechnique Federale, Lausanne, Switzerland). Plasma Phys.; 17: No. 7-8, 633-636 (Jul 1975).

A large amplitude ordinary wave is shown to decay into another ordinary wave and either an upper or a lower hybrid wave. Threshold values of the pump power and growth rates of the excited waves are obtained for various cases. (auth)

**27779** BEAM INSTABILITY IN INHOMOGENEOUS BOUNDED PLASMA. Amein, W. H.; Dolgopolov, V. V.; Hussein, A. M.; Zayed, K. E. (Atomic Energy Establishment, Cairo). Plasma Phys.; 17: No. 6, 497-500(Jun 1975).

A great number of publications are devoted to the theoretical study of beam instability in a plasma. However, in most cases the research has been done in the approximation of a homogeneous unbounded plasma. Plasma, however, is always bounded and inhomogeneous under experimental conditions. Longitudinal one-dimensional oscillations in a plasma, which is inhomogeneous and bounded in the direction of beam motion are considered in this paper. Oscillations are more intense, when injected from an external source. This source is considered to be monochromatic. In this case, a beam-plasma interaction takes the form of an amplification of waves by the beam. It is shown that due to the resonant rise of the wave field with plasma dielectric permeability reducing to zero, the power absorbed by the plasma is finite and independent of the value of the dissipation. Therefore, the beam not only amplifies waves in the plasma, but also provides for effective absorption of these waves by the plasma. (auth)

**27780** THERMAL INSTABILITY IN PLASMA WITH FINITE LARMOR RADIUS. Sharma, R. C.; Prakash, K. (Himachal Pradesh Univ., Simla (India). Dept. of Mathematics). Z. Naturforsch., A; 30: No. 4, 461-465(Apr 1975).

3 figs.; 9 refs.

The effects of the finite Larmor radius of the ions on the thermal instability of a plasma are investigated. When the instability sets in as stationary convection, the finite Larmor radius is found to have a stabilizing effect. The conditions for the nonexistence of overstability are investigated. The case with horizontal magnetic field is discussed. (auth)

**27781** ENERGY BALANCE METHOD FOR FINDING THE THRESHOLD FIELD OF DECAY PARAMETRIC INSTABILITY IN A WARM MAGNETO-ACTIVE PLASMA. Zhelyazkov, I. I.; Nenovski, P. I. (Univ., Sofia). Bulg. J. Phys.; 11: No. 1, 78-84(1975).

On the ground of a hydrodynamic magnetoactive plasma model, an efficient method is developed for finding the threshold field for decay parametric instability in infinite plasmas. The method is based on the balance of the energy input into the plasma by the high-frequency electric field and the energy absorbed by the plasma particles as a result of the dissipative losses. The analysis gives a clear physical picture of the decay process and the

threshold field derived here coincides with the value obtained by another kinetic method. (auth)

**27782** HELICAL EQUILIBRIUM AND THE CRITERION FOR KINK INSTABILITY OF A CYLINDRICAL TOKAMAK. Inoue, S.; Itoh, K.; Yoshikawa, S. (Tokyo Univ. (Japan). Dept. of Physics). Phys. Lett., A; 53: No. 4, 342-344(30 Jun 1975).

By means of the neighbouring equilibrium method, criteria of the kink instability for "camel hump" (skin like) current distributions are obtained numerically. It is found that camel hump distribution plasmas are more stable than flat current plasmas. (auth)

**27783** NATURE OF TRAPPED PARTICLE INSTABILITY. Krishan, S.; Krishan, V. (Indian Inst. of Science, Bangalore). Phys. Lett., A; 53: No. 5, 425-426(14 Jul 1975).

The amplification mechanism for the side bands which accompany a large amplitude electron wave on a plasma column are shown to arise due to two mode interaction between negative and positive energy waves. (auth)

**27784** ION SPACE CHARGE INSTABILITY INDUCED BY A GRID IN A Q-MACHINE PLASMA. Popa, G.; Sato, N.; Maerk, E.; Schrittwieser, R.; Mravlag, E. (Innsbruck Univ. (Austria). Inst. fuer Theoretische Physik). Phys. Lett., A; 53: No. 5, 427-428(14 Jul 1975).

An instability is induced by a negatively-biased grid, situated between a hot plate and a cold end plate in a single ended Q machine, when the cold plate is biased to form a space charge between the grid and the cold plate. (auth)

**27785** DRIFT THERMONUCLEAR INSTABILITIES. Mikhailovskii, A. B. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1772-1782(May 1975). (In Russian).

Plasma instabilities due to $\alpha$-particles produced in thermonuclear reactions are investigated theoretically. It is demonstrated that the theory of thermonuclear instabilities developed earlier is incomplete and does not take into account those instabilities which are the most important from the viewpoint of the theory of turbulent transfer of plasma across the magnetic field in toroidal traps of the Tokamak type. Such instabilities, which are studied in the paper, are due to spatial inhomogeneity in distribution of $\alpha$-particles and to the curvature of the magnetic field lines. Instabilities are considered which are induced by both traversing as well as trapped $\alpha$-particles. (auth)

**27786** STABILIZATION OF THE ION ACOUSTIC INSTABILITY BY HIGH FREQUENCY OSCILLATIONS. Pecseli, H. L. (Association Euratom-Danish AEK, Physics Department AEK Risoe, DK4000 Roskilde, Denmark). Phys. Lett., A; 53: No. 6, 491-492(28 Jul 1975).

The dielectric function for long wavelength, low frequency ion waves in the presence of short wavelength, high frequency electron oscillations is presented. It is shown that high frequency oscillations may stabilize a linearly unstable double-humped ion distribution function. (auth)

# Thermonuclear Engineering and Equipment

*Refer also to abstract 28788, 28791, 28877, and 30131.*

**27787** (BNL-20376) VERSION OF THE MORSE MULTIGROUP TRANSPORT CODE FOR FUSION REACTORS BLANKETS AND SHIELDS STUDIES. Ragheb, M. M.; Maynard, C. W. (Brookhaven National Lab., Upton, N.Y. (USA)). 30 Aug 1975. 29p. Dep. NTIS $4.50.

A guide for the use of a new version of the Morse Monte Carlo Multigroup neutron and gamma ray transport code with combinatorial geometry is presented. This version is in current use for neutronics studies of blankets and shields for fusion power reactors designs. A benchmark problem treating a cell calculation for a fusion reactor blanket and shield design is presented. The modifications introduced to the different routines, the deck organization for the CDC-7600 computer system, a sample problem input and output, and a set of recommendations are given. (auth)

**27788** (CLM-R-142) STUDIES OF THE MAGNETIC CONFIGURATION OF AN l = 2 STELLARATOR. Fedyanin, O. I. (UKAEA Research Group, Abingdon. Culham Lab.). May 1975. 26p. Dep. NTIS (US Sales Only) $4.50. UK pounds 1.00.

The first part of this report describes a computational study of the effect of first and second order resonances on an l = 2 stellarator, taking as a model the PROTO-CLEO experiment. The magnetic surfaces are computed in each case and the break up shown. The second part of the report deals with measurements made with an electron beam on the PROTO-CLEO l = 2 stellarator. The magnetic surfaces are measured by means of a movable probe which intercepts the beams. It is shown that the form of the surfaces, particularly near the separatrix, is sensitive to quite small perturbations of a resonant type. (auth)

**27789** (CONF-750705-4) ATOMIC PHYSICS IN THE CONTROLLED THERMONUCLEAR RESEARCH PROGRAM. Barnett, C. F. (Oak Ridge National Lab., Tenn. (USA)). 1975. 8p. Dep. NTIS $4.00.

From 9th international conference on physics of electronic and atomic collisions; Seattle, Washington, USA (24 Jul 1975).

The atomic processes involving plasma heating, cooling, and diagnostics as related to tokamak-type devices are discussed. (MOW)

**27790** (CONF-750723-17) EFFECT OF PLASMA PHYSICS ON CHOICES OF FIRST WALL MATERIALS AND STRUCTURES FOR A THERMONUCLEAR REACTOR. Meade, D. M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). 1975. 22p. Dep. NTIS $4.25.

From international conference on radiation test facilities for the CTR surface and materials program; Argonne, Illinois, USA (15 Jul 1975).

Impurity ions adversely affect the behavior of present-day tokamaks, and control of impurities is expected to be a key element in determining the feasibility of thermonuclear fusion reactors. In this paper, we describe the plasma-surface interactions for tokamaks and several techniques for controlling impurities. The plasma-surface problem of next generation devices PLT, PDX, DIII and TFTR is expected to be similar to those encountered in a reactor. For these devices calculations indicate that most of the particle energy efflux will be in the 1 keV region. Ironically this energy region has not yet been investigated thoroughly by the surface physicists. (auth)

**27791** (CONF-750723-18) ION BEAM PELLET FUSION AS A CTR NEUTRON TEST SOURCE. Arnold, R.; Martin, R. (Argonne National Lab., Ill. (USA)). Jul 1975. Contract W-31-109-Eng-38. 22p. Dep. NTIS $4.25.

From international conference on radiation test facilities for the CTR surface and materials program; Argonne, Illinois, USA (15 Jul 1975).

Pellet fusion, driven by nanosecond pulses containing alpha particles with 200 MeV energy, is being developed as a neutron source. A prototype system is in the conceptual design stage. During the coming year, engineering design of required accelerator components, storage rings, and pellet configurations, as well as experiments on energy deposition mechanisms, should be accomplished. Successful construction and tests of prototype rings, followed by two years of full scale system construction, would give a source producing a useful flux of fusion neutrons for materials testing. The system as currently envisioned would employ 100 small superconducting high field storage rings (15 cm radius, 140 kG field) which would be synchronously filled with circulating 1 nsec pulses from a 200 MeV linear accelerator over a period of $3 \times 10^{-4}$ sec. These ion pulses would all be simultaneously extracted, forming a total current of 10 kA, and focussed from all directions on a deuterium and tritium (DT) pellet with 0.17 mm radium, surrounded by a heavier (metal) coating to increase confinement time and aid compression efficiency. The overall repetition rate, limited principally by physical transport of the pellets, could reach 100/sec. Spacing between pellet and focussing elements would be about 1 m. The predominant engineering problems are the fast extraction mechanism and beam transport devices for the storage rings. Additional theoretical and experimental studies are required on the crucial energy deposition and transport mechanisms in pellets with ion beam heating before firm estimates can be given. Preliminary estimates suggest fusion neutron yields of at least $10^{14}$/sec and possibly $10^{16}$/sec are possible, with optimal pellet dynamics, but without the necessity for any large advances in the state-of-the-art in accelerator and storage ring design. (auth)

**27792** (CONF-750944-15) TECHNICAL ASSESSMENT OF THE POTENTIALS OF PULSED HIGH-BETA PLASMA DEVICES AS CTR RADIATION TEST FACILITIES. Persiani, P. J. Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 5p. Dep. NTIS $4.00.

From 3rd topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The study is divided into two general areas: surface radiation effects and bulk radiation effects. Test conditions and requirements for plasma source and dense plasma focus are described. The overall facility design is briefly discussed. (MOW)

**27793** (CONF-751023-4) MEASUREMENT AND MODIFICATION OF FIRST-WALL SURFACE COMPOSITION IN THE OAK

RIDGE TOKAMAK (ORMAK). Clausing, R. E.; Emerson, L. C.; Heatherly, L.; Colchin, R. J.; Twichell, J. C. (Oak Ridge National Lab., Tenn. (USA)). 1975. 22p. Dep. NTIS $4.25.

From 22nd national vacuum symposium; Philadelphia, Pennsylvania, USA (28 Oct 1975).

Impurities coming into the plasma from the walls of present-day toroidal plasma confinement devices modify plasma behavior substantially. Small fractions of high-Z ions in the plasma greatly decrease plasma temperatures and increase plasma energy losses. Impurities from the "first-wall" in ORMAK were studied. Auger electron spectroscopy, soft x-ray appearance potential spectroscopy, and other surface sensitive techniques were used to characterize the surface composition of the first wall and to develop methods to remove carbon and oxygen. Oxygen glow discharge cleaning has been shown, in the laboratory, to be an effective way of removing carbon from gold films (simulated ORMAK linear material) and the use of oxygen discharge cleaning in ORMAK has resulted in a decrease in plasma contamination, a 50 percent increase in plasma current and an accompanying increase in plasma temperature. In spite of these improvements the walls of ORMAK are far from clean. Substantial amounts of carbon, oxygen, iron and other elements remain. (auth)

**27794** (KFTI-74-35) ON THE PERTURBATION OF THE STELLATOR MAGNETIC STRUCTURE BY LONGITUDINAL PLASMA CURRENT. Aleksin, V. F.; Pyatov, V. N.; Sebko, V. P.; Tyupa, V. I. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 17p. (In Russian). INIS.

The longitudinal current in a plasma whose density drops linearly or parabolically from the center was shown, in the case of resonance activation, to be able to change the structure of the configuration of a stellarator. In twisting of the helical lines of force by the longitudinal current, as a result of a decrease in the width close to the effective magnetic surface rather large resonance rosettes are formed. In the case of uncoiling of lines of force by the current in the plasma along with appearance of rosettes, the total angle of rotational transformation in the peripheral part of the configuration decreases. The results of calculations agree with experimental data obtained on stellarators with a current-carrying plasma. (tr-auth)

**27795** (LA-UR-75-1508) STAGE THETA PINCH EXPERIMENTS. Linford, R. K.; Downing, J. N.; Gribble, R. F.; Jacobson, A. R.; Platts, D. A.; Thomas, K. S. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944-10). Dep. NTIS $4.00.

From 3rd topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Staged Theta Pinch program is designed to study the technological and physics problems associated with producing fat plasmas and separating the implosion heating from the adiabatic compression. Several methods of implosion heating are discussed. Circuit diagrams and theoretical magnetic field behavior are described for the STP and resonant heating experiments. (MOW)

**27796** (LA-UR-75-1509) STABILITY AND DIFFUSION OF THE ZT-1 REVERSED-FIELD PINCH. Haberstich, A.; Baker, D. A.; Di Marco, J. N.; Mann, L. W.; Ortolani, S. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944-9). Dep. NTIS $4.00.

From 3rd topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The ZT-1 reversed-field pinch experiment has been operated in the so-called derated mode at peak toroidal currents of 40 to 110 kA with initial rates of rises of 60 to 200 kA/mus and filling pressures ranging from 8 to 120 mTorr. The experiments reported here were aimed at establishing the effect of diffusion on magnetic field programming and MHD stability. Some of these studies have been extended to a new derated mode of operation with matched risetimes of the applied poloidal and toroidal fields. The Mercier criterion of stability was computed for certain toroidal configurations. (auth)

**27797** (LA-UR-75-1757) LASER SYSTEMS FOR HIGH PEAK-POWER APPLICATIONS. Fenstermacher, C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 9p. (CONF-750666-2). Dep. NTIS $4.00.

From seminar on optical methods in energy conversion; Rochester, New York, USA (23 Jun 1975).

Large scale programs are under way at major laboratories to study the feasibility of laser-induced fusion. The laser requirements for this investigation are formidable and it is estimated that powers in the range of 100 terrawatts with total energies of $10^5$ to $10^6$ joules may be needed. A major fraction of the effort has been directed toward the development of high-energy short-pulse lasers which can meet these requirements. The parameters of the $CO_2$ laser system have been extensively studied and it appears that the efficiency, energy density, bandwidth, and optical damage limits are compatible with the requirements. The scaling laws are also now well understood. Based upon these results, several large carbon dioxide systems have been developed by the Los Alamos Scientific Laboratory. The first system has been in operation for several years at a power of 0.2 terrawatt with a focused intensity of $5 \times 10^{14}$ W/cm$^2$. A second system with power and energy outputs increased by an order of magnitude will be operating presently. Succeeding systems are being planned and developed to extend this performance to the range of interest for laser fusion energy production. (auth)

**27798** (LBL-3260) EXPERIMENTAL AND THEORETICAL DEVELOPMENTS IN TOROIDAL CUSP CONFINEMENT (TORMAC). Boozer, A. H.; Kunkel, W. B.; Levine, M. A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-Eng-48. 4p. (CONF-750905-20). Dep. NTIS $4.00.

From 7th European conference on controlled fusion and plasma physics; Lausanne, Switzerland (1 Sep 1975).

Stable hydromagnetic equilibrium was demonstrated in a two-pole toroidal cusp experiment at beta approximately 1 (n/sub i/ approximately $2 \times 10^{15}$ cm$^{-3}$, kT approximately 10 eV). Higher temperatures are expected in a larger device, under construction, in which wall contact is avoided. Theoretical considerations predict both stability and good confinement in the long mean-free-path limit. (auth)

**27799** (LBL-3296) TFTR NEUTRAL BEAM INJECTION SYSTEM CONCEPTUAL DESIGN. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 29 Aug 1975. Contract W-7405-ENG-48. 141p. Dep. NTIS $5.45.

Three subsystems are described in the following chapters: (1) Neutral Beam Injection Line; (2) Power Supplies; and (3) Controls. Each chapter contains two sections: (1) Functions and Design Requirements; this is a brief listing of the requirements of components of the subsystem. (2) Design Description; this section describes the design and cost estimates. The overall performance requirements of the neutral beam injection system are summarized. (MOW)

**27800** (MATT-1079) EFFECTS OF IMPURITIES AND MAGNETIC DIVERTORS ON HIGH-TEMPERATURE TOKAMAKS. Meade, D. M.; Furth, H. P.; Rutherford, P. H.; Seidl, F. G. P.; Duechs, D. F. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1974. Contract AT(11-1)-3073. 16p. (IAEA-CN-33/A15-4). Dep. NTIS $4.00.

A one-dimensional tokamak plasma transport code has been adapted to include impurity influx, stripping, radiation, and diffusion, as well as the usual processes of hydrogen plasma and heat transport, recycling at the boundary, and multigeneration charge-exchange. Neutral-beam heating, adiabatic compression, and divertor boundary conditions are included as optional features. Illustrative computations are given for present-day and next-generation tokamaks. The problems of impurity control are discussed, and two technical approaches are examined in greater detail: the transient cold-plasma shield, and the poloidal divertor. (auth)

**27801** (MATT-1082) PRINCETON REFERENCE DESIGN FUSION POWER PLANT. Price, W. G. Jr. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 9p. (IAEA-CN-33/G1-4). Dep. NTIS $4.00.

The Princeton Reference Design Fusion Power Plant is an electrical generating station based upon a large Tokamak confining a D-T plasma. The plasma major and minor radii are nominally 10.5 m by 3.2 m; the toroidal field at the center-line is 6 T. With a mean ion temperature of 30 keV, an average beta of 0.04, and an average tau of 3.83 s a fusion power of 3440 MW is achieved during 97 minutes of the 100 minute long-pulse cycle. The plasma throughput of $2.8 \times 10^{22}$ ions/s is deflected down a divertor channel where it cools by radiation and is neutralized, exhausting as hot gas to the vacuum pumps. The total thermal power of 5305 MW is carried by a helium coolant to a conventional steam cycle producing 2030 MWe net. Tritium is bred in an 80 cm thick blanket of eutectic flibe (53.1 percent beryllium fluoride and 46.9 percent lithium fluoride) with Nimonic PE-16 (43 percent nickel, 39 percent iron, 18 percent chromium) as the structural material; the blanket-averaged volume fractions are 69.8 percent flibe, 9.4 percent PE-16, and 20.8 percent helium. The breeding ratio of 1.04 will allow doubling of the 2.57 kg inventory in 121 days. The nominal wall load of 1.76 MW of DT neutrons per m implies a total flux of $8.65 \times 10^{18}$ n/m$^2$.s at the wall and a corresponding helium production rate of 275 ppm/year. (auth)

**27802** (MATT-1083) TEST RESULTS OF $Nb_3Sn$ RIBBONS FOR THE PRINCETON D COIL TEST PROGRAM. Kaugerts, J.; File, J.; Willard, J. W. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1974. Contract AT(11-1)-3073. 5p. Dep. NTIS $4.00.

A previously described D coil test program was modified. Details of a smaller $Nb_3Sn$ D coil test program are described. Cusp coil tests were made with several $Nb_3Sn$ composite ribbons. Measurements of both the quench and recovery currents as a function of magnetic field component perpendicular to the wide edge of the ribbon are presented. (auth)

**27803** (MATT-1102) NEUTRON WALL LOAD DISTRIBUTIONS IN A CIRCULAR CROSS SECTION TOKAMAK. Price, W. G. Jr.; Chapin, D. L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 44p. Dep. NTIS $5.25.

The distributions of the angular and scalar flux and current around the wall of a circular cross section tokamak are calculated by numerically solving the integral form of the neutron transport equation. The effect of the toroidal geometry is taken into account while investigating three different isotropic plasma source distributions–uniform, peaked, and shifted. The results of the calculations for a typical large scale tokamak design indicate a strong dependence of the scalar flux and the current (of DT neutrons) on the wall position, resulting in "hot spots" on the wall. The calculations also indicate a marked variation of the angular flux of DT neutrons with the wall position, which may be an important consideration in wall sputtering and tritium breeding evaluations. The angular distribution is used as a source condition for the neutron transport code ANISN, to investigate the effect on the flux and tritium breeding ratio in a fusion reactor blanket. (auth)

**27804** (MATT-1104) IGNITRON LONG PULSE TESTING. Bronner, G.; Murray, J. G.; Duritt, S. P. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 29p. Dep. NTIS $4.50.

Tests were performed on three types of ignitrons at current levels of from 2500 to 5000 Amperes and conduction periods of up to 5 seconds. Both mechanical deterioration and changes in certain electrical static characteristics were observed and used as criteria for test terminations. Significant results were the selection of a moderately priced tube type for the PLT ohmic heating system and the choice of a conductor connection arrangement which extends tube life. (auth)

**27805** (MATT-1134) MAGNETIC FIELDS FROM STRAIGHT FILAMENTS, RECTANGULAR SHEETS, AND RECTANGULAR BARS. Christensen, U. R.; Weissenburger, D. W.; Dreskin, S. A. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Aug 1975. Contract AT(11-1)-3073. 21p. Dep. NTIS $4.25.

The derivation and the use of three Fortran programs are described: FIFL equals Field from a straight filament of finite length. FIRS equals Field from a rectangular sheet of infinitesimal thickness. FIRB equals Field from a rectangular bar of finite length. The three geometries in question might suggest a logical extension of the solution for the simplest geometry, i.e., the linear filament, into the successively more complicated cases, i.e., the rectangular sheet and the rectangular bar. The programs to be discussed were; however, developed independently. Each program is, therefore, the result of a different mathematical approach and is discussed. (auth)

**27806** (NP-20575) METHOD FOR MEASURING THE FIELD-INDEX IN A TOKAMAK. van der Laan, P. C. T. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Apr 1975. 5p. Dep. NTIS (US Sales Only) $4.00.

A description is given of various types of coils with which the field-index of the vertical field in a Tokamak can be measured. Other applications of the described coils are: a measurement of the radius of curvature of a general vacuum field, a measurement of the derivative of the field along the field lines and a measurement of the field penetrating a hollow cylinder. (auth)

**27807** (ORNL-TM-5013) DT AND ADVANCED FUSION FUELS COMPUTER CODE. Sharp, R. D.; McNally, J. R. Jr. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 90p. Dep. NTIS $5.45.

A simulation model has been developed to explore the prospects of using advanced fuels (D + D, D + $^6$Li) for fusion reactors. The Etzweiler, Clarke, and Fowler (ECF) zero dimensional code was adapted to look at the reactivity of such fuels. The model consists of a system of simultaneous first order differential equations depicting particle densities and ion and electron temperatures. This model does not pretend to be the most efficient one possible, but it has given consistent and explainable results. The code can easily be modified to expand its range of reactions (e.g., $^3$He + $^3$He, P + $^{11}$B, etc.). (auth)

**27808** (ORNL-TM-5033) NEUTRONICS CALCULATIONS FOR THE TOKAMAK EXPERIMENTAL POWER REACTOR REFERENCE DESIGN. Santoro, R. T. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 15p. Dep. NTIS $4.00.

The results of initial one-dimensional calculations evaluating the nuclear performance of the Tokamak Experimental Power Reactor are presented. Estimates of the tritium breeding, nuclear heating, and radiation damage are given for an assumed neutron wall loading of 0.168 MW/m$^2$ (100 MW). (auth)

**27809** (UCID-16864) SCALING OF ELECTRON BEAM SOURCES FOR LASER FUSION APPLICATIONS. Schlitt, L. G.; Bradley, L. P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jul 1975. Contract W-7405-Eng-48. 68p. Dep. NTIS $6.50.

The purpose of this study is to develop a scheme for constructing electron beam machines capable of pumping large volumes of gas, to analyze their performance within the framework of existing knowledge of the physical mechanisms involved, to use this analysis to assess the viability of the overall concept, pinpoint weaknesses in the understanding of the physics, identify the most important limiting physical processes, and hence to propose a program to prepare for the eventual construction of a large scale gas laser system. (auth)

**27810** (UCID-16900) DT FUSION NEUTRON IRRADIATION OF LLL INITIAL DAMAGE RATE SAMPLES AT 4.2$^0$K. MacLean, S. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Jul 1975. Contract W-7405-Eng-48. 5p. Dep. NTIS $4.00.

Initial damage rate studies at 4.2$^0$K were performed. One of the samples was used for dosimetry. It was a niobium wire measuring approximately 90 mm in length, 0.127 mm in width, and 0.025 mm in thickness. The irradiation was carried out by the LLL E Division Accelerator Staff. Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose record is attached. The total beam-on time was 10.75 hours. (MOW)

**27811** (UCRL-13632) LASER FUSION SYSTEM DESIGN STUDY. Final Report. (Aerojet ElectroSystems Co., Azusa, Calif. (USA)). 14 Mar 1975. 274p. Dep. NTIS $16.75.

For Univ. of California, Livermore.

The following studies were completed: (1) The synthesis of a pointing/control system compatible with existing and advanced laser opto-mechanical configurations. (2) Attainment of the required pointing angle, longitudinal focus, and differential path-length accuracies. (3) Maximum modularization of the sensor and gimbal assemblies to provide the required accuracies at minimum cost. Detailed information is given on each. (MOW)

**27812** (UCRL-76858) HEAVY WATER JET TARGET AND A BERYLLIUM TARGET FOR PRODUCTION OF FAST NEUTRONS. Logan, C. M.; Anderson, J. D.; Barschall, H. H.; Davis, J. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jul 1975. 17p. (CONF-750723-15). Dep. NTIS $4.00.

From international conference on radiation test facilities for the CTR surface and materials program; Argonne, Illinois, USA (15 Jul 1975).

A limitation on the neutron flux obtainable from proton or deuteron induced reactions is the heating of the target by the accelerated charged particles. The heat can be removed more easily if the target moves. The possibility of using a rotating Be target and a heavy water jet as a target for bombardment by 35-MeV deuterons was studied. In a thick Be metal target moving at 10 m/sec through such a beam of 1 cm diameter a temperature pulse of about 300$^0$C will be produced by the 0.3 MW beam. The Be target should be able to withstand such a temperature pulse. A Be target suitable for 3 MW of power in a 1 cm diameter beam would require internal cooling and a higher velocity. A free jet of heavy water is also a possible target. Laser photographs of water jets in vacuum show small angles of divergence. The effect of heating by a 0.3 MW beam is probably not important because the temperature rise produced by the beam is small compared to the absolute temperature of the unheated jet. (auth)

**27813** (UCRL-76890) USER'S VIEW OF FERF. Doggett, J. N.; Vandervoort, R. R.; Barmore, W. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Jul 1975. 31p. (CONF-750723-16). Dep. NTIS $4.75.

From international conference on radiation test facilities for the CTR surface and materials program; Argonne, Illinois, USA (15 Jul 1975).

This report represents a first attempt at coordinating a testing program with a FERF design. The purpose was to gain insight into the value and problems associated with using FERF in a real materials and systems test program. A comparison to the current survey of CTR materials test requirements shows that FERF can

provide virtually all the appropriate experimental space and flux requested (except for very large blanket sections). (MOW)

**27814** SUPERCONDUCTING MAGNETIC ENERGY STORAGE. Laquer, H. L. (Los Alamos Scientific Lab., NM). Cryogenics; 15: No. 2, 73-78(1975).

The reasons for and forms of secondary energy storage, and the elements and history of inductive or magnetic storage are reviewed, and the 4 distinct areas in which superconducting magnetic energy storage can be applied are discussed together with the different requirements on the storage coil, on the switch or transfer element, and on the energy losses in the superconductor by the differences in energy transfer times. The designs and expts. are reported in 1 of these areas with 2-300 kj units and on the analysis and plans for an installation that is to provide 250 MJ of plasma compression energy for the theta-pinch controlled thermonuclear fusion test reactor. The elements of inductive storage that need further development before a theta-pinch fusion reactor becomes economically competitive are indicated. The size and costs are compared of the energy storage components of these systems with similar and with larger inductive storage systems that are to interact reversibly with electric utility networks. (auth)

**27815** ENERGY CRISIS AND A POTENTIAL LASER-FUSION SOLUTION. Siegel, K. M. (KMS Fusion, Inc., Ann Arbor, Mich. (USA)). J. Appl. Sci. Eng., A.; 1: No. 1, 3-18(Apr 1975).

Today, the primary source of energy in the United States is 33% natural gas, 45% oil, 5% electric (from nuclear and hydroelectric) and 17% coal. It is clear that to bring electricity into the household from the primary source of energy, when one utilizes that other 95% of primary energy, it is done so at a loss factor of approximately four. The practical answer would seem to be a development in the direction of a methane economy by the year 2000, and possibly during the next century to develop an all-hydrogen economy, ideally based on laser-fusion techniques. (auth)

**27816** REACTOR FUSION NEEDS GUIDELINES. Ned. Tijdschr. Natuurkd.; 41: No. 8, 85-86(19 Apr 1975). (In Dutch).

The principle of a fusion reactor power station is illustrated–this comprises a plasma in an evacuated chamber surrounded by lithium and thereafter by helium with a vessel encompassed by a magnetic coil. The coolant circuit includes a helium loop with heat exchanger and tritium separator, a deuterium injector and a conventional steam turbine–generator–transmission line output. Development programs and costs are outlined and analyzed from the German, British, and French standpoints. Plans of official bodies noted relate to FOM/RCN, JET (Joint European Tokamak), the IAEA and Euratom. (NL)

**27817** DIFFUSION OF QUASISTATIONARY HELICAL MAGNETIC FIELDS INTO THE INTERIOR OF CYLINDRICAL CHAMBERS. II. Aleksin, V. F.; Romanov, S. S. Sov. Phys.–Tech. Phys.; 19: No. 9, 1171-1173(Mar 1975).

Translated from Zh. Tekh. Fiz.; 44: No. 9, 1877-1882(Sep 1974).

The penetration times for quasistationary magnetic fields in a conducting cylindrical shell and in a solid conducting cylinder are computed. In both cases, the penetration time of the field is determined by the conducting properties of the material and the spatial periods of the currents that excite the field. (auth)

**27818** PRESENT STATE OF FUSION REACTOR DEVELOPMENT. Knobloch, A. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Mitt. Max-Planck-Ges. Foerderung Wiss.; No. 5, 342-359(Nov 1974). (In German).

The short review of the present state of fusion reactor development deals with: research invests, advantages of fusion reactors, plasma trapping and Lawson-diagram with present experimental results, fusion reactor with magnetic plasma trapping, energy delivering D-T-reactions, Tokamak- and Stellarator-principle, energy conversion and tritium breeding, technological problems and present models for wall- and blanket-materials, optimum Tokamak-ideal-reactor with central electric station at the present knowledge, comparison with experimental data. (GE)

**27819** RECENT ADVANCES AND PROSPECTS OF CONTROLLED THERMONUCLEAR FUSION. Caldirola, P. (CNR, Milan). Termotecnica (Milan); 29: No. 3, 121-125(Mar 1975). (In Italian).

Emphasis is made on the three points on which it is possible to summarize the basic problems of controlled thermonuclear fusion. These are the physical principles of nuclear fusion, characteristics of the principal experimental devices, and the design of a fusion reactor. The designs discussed are tokamak-type reactors. (JSR)

**27820** TRANSIENT BEHAVIOR OF CURRENTS AND FORCES IN THE TOROIDAL COIL SYSTEM OF THE STELLARATOR WENDELSTEIN VII ESPECIALLY IN THE CASE OF OPERATIONAL DISTURBANCES. Preis, H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F.R. Germany)). Arch. Elektrotech. (Berlin); 56: No. 3, 120-127(1974). (In German).

9 figs.; 1 tab.; 12 refs.

Fusion machines with closed magnetic field configurations have emerged as the principal means of achieving magnetic confinement of plasmas. The transient coil currents occurring during a current pulse produced with a pulse power generator are analyzed for the W VII stellarator experiment at Garching. Allowance is made for all inductive coupling, both in smooth operation and in the case of sudden coil shorting. The currents determined are used to calculate the magnetic forces exerted on coils (Lorentz forces) as functions of time and short-circuit impedance. (GE)

**27821** CORAL GABLES CONFERENCE ON NUCLEAR FUSION BY LASERS, ELEMENTARY PARTICLES, AND RELATIVISTIC ASTROPHYSICS, CORAL GABLES, FLORIDA, JANUARY 19 TO 24, 1975. Hora, H. Atomkernenergie; 25: No. 1, A2, A4(1975).

The most important reports are summarized and annotated. (GE)

**27822** DISPOSITION OF SUPERCONDUCTION TECHNOLOGY FOR FUSION RESEARCH. Komarek, P. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). KFK Nachr.; 7: No. 1, 1-9(1975). (In German).

9 figs.; 1 tab.; 4 refs.

The paper describes the magnetic system of a Tokamak arrangement and the development of superconductive energy storage devices for fusion magnets. (GE)

## Wave Phenomena

**27823** (IPP-6/136) STRONG TURBULENCE THEORY AND THE TRANSITION FROM LANDAU-TO COLLISIONAL DAMPING. Dum, C. T. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Jun 1975. 11p. Dep. NTIS (US Sales Only) $4.00.

New methods are introduced for a quantitative evaluation of the dielectric constant describing the interaction of a long wavelength test wave with electrons in the presence of electron-ion collisions or small scale turbulence. It is shown that the usual resonance broadening arguments of strong turbulence theory do not apply. (auth)

**27824** (LA-2715) SCATTERING OF ELECTROMAGNETIC WAVES BY NONEQUILIBRIUM PLASMAS. Lamb, G. L. Jr. (Los Alamos Scientific Lab., N. Mex. (USA)). 1 Mar 1962. Contract W-7405-eng-36. 65p. Dep. NTIS $6.25.

The frequency spectrum of the cross section for the scattering of electromagnetic waves by a plasma is known to be proportional to the Fourier transform of the two-point time-dependent correlation function for the electron density fluctuations of the plasma. This spectrum has previously been obtained for two-component plasmas in complete thermal equilibrium. In the present calculation, methods recently developed by Rosenbluth and Rostoker are employed to obtain the spectrum for plasmas which are out of thermal equilibrium but sufficiently stationary in time for fluctuations about their state of quasi-equilibrium to take place. It is found that the spectrum has the same functional dependence upon the nonequilibrium distribution function as was found previously for plasmas in complete thermal equilibrium. The specific nonequilibrium plasmas considered are ions and electrons at different temperatures, and counter streaming ions and electrons with various temperature ratios. Amplification of the spectrum in the ion wave region as the relative drift velocity of ions and electrons approaches the critical drift velocity for the onset of electrostatic instability is obtained, as well as the enhancement of this amplification with the lowering of the ion temperature. (auth)

**27825** (MATT-1073) ENHANCED INDUCED EMISSION FOR STIMULATED RAMAN SCATTERING IN PLASMAS. Auer, G.; Oberman, C. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Sep 1974. Contract AT(11-1)-3073. 7p. Dep. NTIS $4.00.

It is shown how longitudinal bremsstrahlung can be included in the formalism for calculating the enhanced induced emission of high-frequency waves in a plasma influenced by a pump field. (auth)

**27826** (MATT-1084) ENERGY TRANSPORT ACROSS A MAGNETIC FIELD BY PLASMA WAVES. Canosa, J.; Okuda, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 46p. Dep. NTIS $5.50.

Cross-field energy transport by electrostatic plasma waves was studied theoretically and numerically for a plasma near thermal equilibrium. Energy transfer by plasma waves is significant in a high temperature plasma where collisional transport is quite small. For strong magnetic fields (omega/sub c/ greater than or equal to omega/sub p/), the simulations verify the theoretical prediction that energy transport by plasma waves increases slowly with the magnetic field, and that in the limit of large field magnitudes wave transport dominates classical collisional transport. Furthermore, in a strong magnetic field the relaxation of the temperature by wave transport may result in an anisotropic velocity distribution. For weak fields (omega/sub p/ greater than omega/sub c/), the simulation shows that collisional transport is more important than wave transport, also in agreement with the theory. (auth)

**27827** (MATT-1090) EXCITATION OF LOWER-HYBRID WAVES BY A SLOW-WAVE STRUCTURE. Bellan, P.; Porkolab, M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 14p. Dep. NTIS $4.00.

The excitation of lower hybrid waves by a multiple ring slow wave structure (4 waves, lambda equals 23 cm) in a magnetized plasma is discussed. Wavelengths measured parallel and perpendicular to the magnetic field were in agreement with the theoretical dispersion relation. The waves propagated in a packet defined by the axial length of the slow wave structure. (auth)

**27828** (MATT-1108) EXCITATION OF ALFVEN WAVES BY HIGH-ENERGY IONS IN A TOKAMAK. Rosenbluth, M. N.; Rutherford, P. H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 15p. Dep. NTIS $4.00.

It is shown that shear Alfven waves can be destabilized by resonance with high-energy "beam" ions near the magnetic axis in a tokamak, if the beam is radially nonuniform. (auth)

**27829** (N-74-18366) NEW ION ACOUSTIC INSTABILITY. Final Report, 28 January 1965–30 June 1971. Leprince, P.; Peyraud, J. (Paris-11 Univ., 91–Orsay (France). Lab. de Physique des Plasmas). Sep 1973. 28p. (LP-144). NTIS $4.50.

In the presence of a quasi-resonant high frequency field, a new type of ion acoustic instability is described. In using the macroscopic equations, it is possible to show that an ion acoustic wave can be unstable when the high frequency is close to the resonance frequency. The experiment is performed on an afterglow discharge; the secondary (or Dattner) resonance is excited. When the incident power increases, the reflected microwave is modulated by a low frequency, corresponding to the frequency of the ion acoustic oscillation. (auth)

**27830** (ORO-4338-7) ION ACOUSTIC WAVES IN LARGE RADIO-FREQUENCY ELECTRIC FIELDS. Lee, A.; Jones, W. D.; Gleman, S. M.; Doucet, H. J. (University of South Florida, Tampa (USA). Dept. of Physics). 20 Aug 1975. Contract AT(40-1)-4338. 16p. Dep. NTIS $4.00.

The propagation of ion acoustic waves (IAW) in high-frequency fields is experimentally studied. The resulting phase-velocity shift and enhanced damping are observed for RF-field amplitudes up to alpha/sub e/ approximately equal to .5, where alpha/sub e/ equals eE/(m/sub e/omega$_0$v/sub e/) is the normalized amplitude. Good agreement with the theory of Albright is found. (auth)

**27831** (UCID-16803) REFLECT: A PROGRAM TO INTEGRATE THE WAVE EQUATION THROUGH A PLANE STRATIFIED PLASMA. Greene, J. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Apr 1975. Contract W-7405-Eng-48. 64p. Dep. NTIS $5.45.

A program was developed to integrate the wave equation through a plane stratified plasma with a general density distribution. The reflection and transmission of a plane wave are computed as a function of the angle of incidence. The polarization of the electric vector is assumed to be perpendicular to the plane of incidence. The model for absorption by classical inverse bremsstrahlung avoids the improper extrapolation of underdense formulae that are singular at the plasma critical surface. Surprisingly good agreement with the geometric-optics analysis of a linear layer was found. The system of ordinary differential equations is integrated by the variable-step, variable-order Adams method in the Lawrence Livermore Laboratory Gear package. Parametric studies of the absorption are summarized, and some possibilities for further development of the code are discussed. (auth)

**27832** (UCID-16891) RELATION BETWEEN LAGRANGIAN SOLUTIONS AND BERSTEIN–GREENE–KRUSKAL MODES IN A COLD PLASMA. Albritton, J.; Rowlands, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1975. Contract W-7405-Eng-48. 5p. Dep. NTIS $4.00.

Davidson and Schram (Nuclear Fusion 8, 183, (1968)) studied, using Lagrangian methods, the phenomena of nonlinear oscillations in a cold plasma. In particular they conclude that their solution can never take the form of Bernstein-Greene-Kruskal waves. It is the purpose of this note to point out that this is not so and that for a particular choice of initial conditions, given explicitly below, B-G-K waves can be obtained. (auth)

**27833** QUASI-LINEAR THEORY OF MOMENTUM TRANSFER FROM rf OSCILLATIONS TO A PLASMA INCLUDING THE EFFECT OF COULOMB COLLISIONS. Klima, R.; Sizonenko, V. L. (Ceskoslovenzka Akademie Ved, Prague). Plasma Phys.; 17: No. 6, 463-471(Jun 1975).

An investigation is made into the effect of particle dragging, which occurs when toroidal plasmas are rf heated by travelling waves. A generalized quasi-linear relaxation theory in a collisional plasma is developed, including the effect of the conservation of the longitudinal component of momentum. The dependence of the toroidal current on the amplitude of the rf field and on the plasma parameters is obtained and a saturation effect for this current is found at strong rf fields. (auth)

**27834** CURRENT DRIVEN ION CYCLOTRON WAVES IN COLLISIONAL PLASMA. Chaturvedi, P. K.; Kaw, P. K. (Physical Research Lab., Ahmedabad, India). Plasma Phys.; 17: No. 6, 447-452(Jun 1975).

The stability of obliquely propagating ion cyclotron waves to current flow along the magnetic field lines, in a fully ionized collisional plasma, is examined using fluid equations. It is shown that when a certain threshold current is exceeded, instability results through normally dissipative terms like parallel resistivity, thermal conductivity etc. (auth)

**27835** PARAMETRIC EXCITATION OF ION ACOUSTIC WAVES BY AN EXTERNAL CURRENT IN A MAGNETIZED PLASMA. Lashmore-Davies, C. N.; Ong, R. S. B. (Culham Lab., Abingdon, Eng.). Plasma Phys.; 17: No. 6, 485-492(Jun 1975).

The parametric excitation of ion acoustic waves in a plasma by a low frequency spatially dependent external current source which acts as the pump field is considered. It is shown that there is instability only when the pump resonates with the ion acoustic wave. The threshold and growth rate of the instability are determined for this case. (auth)

**27836** NON-LINEAR LANDAU DAMPING OF PLASMA WAVES. Barbian, E. P.; Hopman, H. J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Ned. Tijdschr. Natuurkd.; 41: No. 9, 109-111(3 May 1975). (In Dutch).

Equations for both linear and non-linear Landau damping are developed in terms of the electron plasma frequency, median thermal velocity, wavelength and plasma radius. Characteristics of plasma wave formation are discussed with respect to Maxwellian energy distributions, growth coefficients, trapped particle instabilities and side-band spectra. Experimental data have been obtained using an axially adjustable energy analyser. A typical trace is illustrated for the side band spectra approximately 3 MHz on either side of the principal frequency of 18 MHz. (GC)

**27837** MHD-STOSSPOLARENDIAGRAMME FUER PLASMEN UNENDLICHER LEITFAEHIGKEIT. (MHD-Shock Polar Diagrams for Plasmas of Infinite Conductivity). Natter, M. VDI-Forschungsheft. Duesseldorf; Verein Deutscher Ingenieure (1974). 40p. (In German).

A graphical representation is developed which allows theoretical investigation of magnetogasdynamic shock configurations, also in connection with tangential discontinuities, for the special case of aligned magnetic and velocity fields. For this aim, scale polar diagrams of the velocity as well as of the magnetic induction and total pressure ratio are established, which take into account the entropy and stability criteria as are valid for MHD-shocks. The fluid medium is assumed to be an ideal monatomic gas of infinite electrical conductivity. The application of the diagrams is demonstrated for some examples (shock flows in corners and past wedges, reflection of an oblique shock wave at a rigid wall, and the intersection of two shocks). These examples were selected as typical for many other flow problems which may be accessible due to this graphical method. (auth)

**27838** INTERACTION OF LANGMUIR SOLITARY WAVES WITH ELECTRONS OF A PLASMA. Gorev, V. V.; Soboleva, T. K. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). Phys. Lett., A; 53: No. 4, 347-348(30 Jun 1975).

Interaction of Langmuir solitary waves with superthermal

electrons of a plasma is considered. The number of solitary waves per unit length N is assumed to be small, therefore interaction of solitary waves with each other may be neglected. The initial phase of the process of relaxation of the electron distribution function is considered numerically. Continuous generation of accelerated electrons up to velocities larger than thermal electron velocities is obtained. (auth)

**27839** OBSERVATION OF E.M. RADIATION AT $F_{pe}$ AND ITS HARMONICS EMITTED BY A TURBULENT PLASMA. Rutgers, W. R.; de Kluiver, H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Phys. Lett., A; 53: No. 5, 423-424(14 Jul 1975).

Electromagnetic radiation emitted by a turbulent plasma is measured. The frequency spectrum shows maxima at harmonics of the plasma frequency. The spectrum was measured between 70 GHz and 300 GHz with relative resolution $R = \lambda/\Delta\lambda$ approximately linearly proportional to $\lambda$. The spectrum clearly shows intensity maxima not only at $f_{pe}$ and $2f_{pe}$ as reported earlier but also at higher harmonics (up to $6f_{pe}$). The intensity of the maxima decreases with increasing frequency. After correction for the bandwidth of the spectrometer a power spectrum $I(f) \sim f^{-3}$ is found. (auth)

**27840** PLASMA ELECTRODYNAMICS. Volume I. Linear Theory. Akhiezer, A. I.; Akhiezer, I. A.; Polovin, R. V.; Sitenko, A. G.; Stepanov, K. N. New York; Pergamon Press (1975). 431p.

The following chapters are presented: (1) kinetic and hydrodynamic methods of describing a plasma, (2) small amplitude MHD waves, (3) simple waves and shock waves in magnetohydrodynamics, (4) hf oscillations in an unmagnetized plasma, (5) oscillations of a plasma in a magnetic field, (6) interaction between charged particle beams and a plasma, and (7) oscillations of a partially ionized plasma. (MOW)

**27841** PHASE CROSS MODULATION OF ELECTROMAGNETIC WAVES ON CYLINDRICAL PLASMA. Gorovenko, A. P.; Fialko, E. I.; Bairachenko, I. V. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 20: No. 3, 497-499(Mar 1975). (In Russian).

The possibility of using nonlinear effects of phase cross modulation for the determination of plasma physics is examined. An expression was obtained for the magnitude of the phase cross modulation as a function of the wave and plasma parameters. It was shown that the effect studied has a magnitude easily registered in tests. (tr-auth)

**27842** NONLINEAR OSCILLATORY WAVEGUIDE PROPAGATION IN A PLASMA. Sodha, M. S.; Prasad, S.; Tripathi, V. K. (Indian Inst. of Tech., New Delhi. Dept. of Physics). Appl. Phys.; 6: No. 1, 119-123(Jan 1975).

5 figs.; 7 refs.

The presence of an intense Gaussian laser beam gives rise to a ponderomotive force on electrons in a collisionless plasma, leading to a redistribution of electron density along the wave-front and consequently to an intensity dependent dielectric constant which saturates with increasing intensity. The intensity dependent dielectric constant is responsible for beam propagation in an oscillatory waveguide. It is seen that (1) a beam of radius r(0) less than r(0 min) (approximately = $c/\omega(p)$) cannot be focused in the plasma regardless of its power, (2) minimum dimension of oscillatory waveguide increases power of the beam. Similar results are also obtained for collisional plasma where nonlinearity arises due to nonuniform heating and consequent redistribution of carriers. (auth)

**27843** THE EFFECT OF RELATIVISTIC PHENOMENA ON LONGITUDINAL OSCILLATIONS IN A MAGNETOACTIVE PLASMA. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Commission, Cairo (Egypt)). Physica; 79: No. 3, 303-310(1975).

It is demonstrated that the allowance for the relativistic nature of oscillations results in the following: (a) the plasma oscillations lose their isochronism (their frequency becomes a function of the amplitude) and (b) the oscillations turn out to be unstable with respect to the development of the sub- and ultra-harmonics of the high-frequency field frequency. (auth)

**27844** NONLINEAR INTERACTION OF S- AND P-POLARIZED WAVES IN A NARROW INHOMOGENEOUS LAYER OF PLASMA. Barakate, A. R.; Dolgopolov, V. V.; El-Siragy, N. M.; Sayed, Y. A. (Atomic Energy Commission, Cairo (Egypt)). Physica; 79: No. 4, 419-425(1975).

The authors investigate nonlinear interaction of waves in a narrow inhomogeneous layer of plasma and at the boundary of a semibounded plasma in the case of simultaneous incidence of S- and P-polarized waves onto the plasma. The amplitudes of the waves with combination frequencies, radiating as a result of the nonlinear interaction, have been found. If the wave-incidence planes coincide then S-polarized waves are radiated at combination frequencies whereas P-polarized waves at double frequencies. (auth)

# ENGINEERING

*Refer also to abstract 28792.*

## Energy Conversion

*Refer also to abstracts 28114, 28119, and 28793.*

## Facilities and Equipment

**27845** (CLM-R-143) REMOTELY OPERATED WELDING MACHINE. Rappe, G. H.; Sanders, B. C. (UKAEA Research Group, Abingdon, Culham Lab.). Jan 1975. 18p. Dep. NTIS (US Sales Only) $4.00. UK 50 pence.

A remotely controlled welding machine used to automatically weld together segments of a large stainless steel torus is described. (auth)

**27846** (ORNL-TM-4929) STRESS INDICES FOR ANSI STANDARD B16.11 SOCKET-WELDING FITTINGS. Rodabaugh, E. C.; Moore, S. E. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 64p. Dep. NTIS $5.45.

Stress indices for ANSI standard B16.11 socket-welding tees, 45° elbows, 90° elbows, and couplings are developed for intended use with the Class-1 piping system design rules of Section III–Division 1 of the ASME Boiler and Pressure Vessel Code. Indices are given for the evaluation of appropriate primary stresses, primary-plus-secondary stresses, and peak stresses due to internal pressure, bending-moment loads, and thermal gradients between the fitting and the attached pipe. The proposed indices are based on the dimensional and pressure-burst requirements of the B16.11 standard, the apparent shapes of B16.11 fittings as indicated from a random sampling taken off-the-shelf, the standard pressure-temperature ratings of the fittings, and on current stress indices now in the Code for similar butt-welding fittings. Specific recommendations are made for issuing the new stress indices in a Code case. (auth)

**27847** SIMPLE METHOD TO TRANSFER SPECIMENS AT LIQUID HELIUM TEMPERATURE. Maeta, H.; Kato, T.; Okuda, S. (Japan Atomic Energy Research Inst., Tokai). J. Phys., E (London); 8: No. 7, 577-578(Jul 1975).

A simple and reliable method to transfer irradiated specimens at liquid helium temperature without any intermediate warming is described. The transfer is performed under the helium gas atmosphere at room temperature using a small vacuum-insulated metal Dewar and consumes only a small amount of liquid helium. (auth)

**27848** PLANNING AND CONSTRUCTION OF PLANTS FOR TREATING SLUDGE. Vater, W. Tech. Mitt.; 68: No. 5, 181-185(Mat 1975). (In German).

6 figs.; 36 refs.

The planning and construction of sludge treatment plants, the hygienization of liquid sludge by pasteurization and irradiation with gamma or electron beams are discussed. At a dose of 200 to 300 Krad irradiating with γ-quanta or at 200 Krad and 400 kV with electron radiation the hygienization effect is similar to that of heat treatment, i.e., a germ number reduction of four to seven powers of ten. Cobalt-60 or waste products from the nuclear reactor industry are used as radiation sources for β-irradiation or electron accelerators. The radiation treatment has the advantage that there is no increase in volume such as in steam treatment and that the slurry can be better drained. (GE)

### Lasers

*Refer also to abstract 28970.*

**27849** (CONF-730750-, pp H1-H18) ANALYTICITY OF THE EIGENVALUES AND EIGENFUNCTIONS OF AN ORDINARY DIFFERENTIAL OPERATOR WITH RESPECT TO A PARAMETER. Scheffler, T. B. (Univ. of Pretoria). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

A general theorem, with simple proof is presented on the analyticity (with respect to a parameter λ) of the eigenvalues and eigenfunctions of a linear homogeneous second order differential operator H(λ). The theorem is more general than commonly used ones (Newton 1960) insofar as the boundary conditions may depend explicitly on the parameter λ and eigenvalue E. Analogous theorems are discussed: the meaning of the condition (C) required in the theorem, and boundary conditions at infinity. Finally the theorem is extended to cover homogeneous and nonhomogeneous linear problems of arbitrary order, and general nonlinear eigenvalue problems. (auth)

**27850** (COO-2521-1) LASERS FOR ISOTOPE SEPARATION. Progress Report, 1 January 1975-31 July 1975. Scully, M. O.; McCarthy, R.J. (Arizona Univ., Tucson (USA). Dept. of Physics). Aug 1975. Contract E(11-1)-2521. 9p. Dep. NTIS $4.00.

Research carried out in four areas related to the general problem of developing lasers for isotope separation is described. The first area of research deals with the general theory of semiconductor lasers. A formalism for semiconductor lasers similar to the Lamb-Scully theory of the gas laser is developed. The second problem considered is the anomalous absorption seen when InSb is irradiated by a high power $CO_2$ laser beam. This effect is important in determining the output power limits of the InSb Raman spin-flip laser. Third, the possibility of producing stimulated emission using free electron beams was investigated. A number of approaches indicating the possibility of obtaining gain from such devices are developed. Considerable work remains to be done to find ways of increasing the gain characteristics. Finally, theoretical and experimental work on $SF_6$ isotope separation via one $CO_2$ laser has been initiated. (auth)

**27851** (COO-2523-2) FAR INFRARED CHEMICAL LASERS. Progress Report, December 1, 1974–July 31, 1975. Robinson, D. W. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Chemistry). Aug 1975. Contract E(11-1)-2523. 53p. Dep. NTIS $5.75.

Flash photolysis of selected mixtures of $O_3/H_2O/O_2$ and $O_3/H_2$ in a laser cavity results in far infrared stimulated emission principally at 357 $cm^{-1}$ and 286 $cm^{-1}$, respectively. Experimental and computational studies of these systems have established the pumping mechanisms. This work has shown the selectivity of both an energy transfer pumping mechanism and an energy of reaction pumping mechanism which in both cases energy matches govern narrowly the upper state in which the inversion builds. Concurrently, the design and fabrication of a laser cavity of twice the length and 25 times the mode volume has proceeded. The goal of this one will be chemical pumping of the HCN laser at 30 $cm^{-1}$. This device has been carried to within, perhaps, three months of becoming operational. (TFD)

**27852** (UCRL-13656) INVESTIGATION OF RF PLASMA LIGHT SOURCES FOR DYE LASER EXCITATION. Kendall, J. S.; Jaminet, J. F. (United Aircraft Corp., East Hartford, Conn. (USA). Research Labs.). Jun 1975. Contract 4751305. 70p. Dep. NTIS $6.50.

For Univ. of California, Livermore.

Analytical and experimental studies were performed to assess the applicability of radio frequency (rf) induction heated plasma light sources for potential excitation of continuous dye lasers. Experimental efforts were directed toward development of a continuous light source having spectral flux and emission characteristics approaching that required for pumping organic dye lasers. Analytical studies were performed to investigate (1) methods of pulsing the light source to obtain higher radiant intensity and (2) methods of integrating the source with a reflective cavity for pumping a dye cell. (TFD)

**27853** ELEMENTARY PROCESSES AND THE MECHANISM OF POPULATION OF WORKING LEVELS IN CONTINUOUS WAVE ION ARGON LASER. Rubin, P. L.; Sobolev, N. N. (Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1693-1705 (May 1975). (In Russian).

Electron excitation cross sections for the working levels of an ion argon laser are calculated in the Born–Coulomb approximation by taking into account autoionization of resonances. Concurrently the radiative transition probabilities are determined. Semiempirical wave functions are employed in the calculations and deviation from a LS coupling is taken into account. Processes of population of working levels in a cw laser are analyzed on basis of these data. It is shown that the $4p^2D_{\frac{1}{2}}$ level is primarily populated as a result of the stepwise process $3p \rightarrow 3d^2F_{\frac{1}{2}} \rightarrow 4p\ ^2D_{\frac{1}{2}}$, whereas the $4p^2P_{\frac{1}{2},\frac{3}{2}}$ levels are mainly populated from the ground state of the ion. The results are compared with the experimental data. (auth)

**27854** INVESTIGATION OF A GASODYNAMIC $N_2O$ LASER. Biryukov, A. S.; Volkov, A. Yu.; Demin, A. I.; Kudryavtsev, E. M.; Kulagin, Yu. A.; Sobolev, N. N.; Shelepin, L. A. (Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1664-1678(May 1975). (In Russian).

A theoretical and experimental investigation was carried out on the mechanism of operation and potentialities of a gasodynamic

$N_2O$ laser in which the working mixture flows through a slit into vacuum. (amplification occurs for the 00°1–10°0 transition, $\lambda \approx 10.9\ \mu$). The following mixtures were investigated: $N_2O$:$N_2$, $N_2O$:HE, $N_2O$:$N_2$:He, $N_2O$:CO:He and $N_2O$:$N_2$:$H_2O$. The kinetics of the physical processes was investigated. It is shown that in contrast to a $CO_2$ laser an important role in the given case is played by nonresonant vibrational exchange which ensures additional pumping to the upper laser level. The dependences of population inversion and amplification factor on the major parameters were calculated. Experimental dependences of the amplification factor on pressure and temperature, on distance from the slit and nitrogen content in the $N_2O$:$N_2$ mixture obtained by means of a shock tube are in qualitative and, in some cases, in quantitative agreement with the theory. It is shown that the maximal inversion exceeds that obtained in a $CO_2$ laser and can be attained at considerably lower temperatures. These advantages of nitrous oxide over $CO_2$ are significant for practical purposes. (auth)

**27855** TIME DEVELOPMENT OF ULTRASHORT PULSE GENERATION FROM A Nd:GLASS LASER WITH A SATURABLE DYE AND SHORT LASER PULSE DAMAGE OF GaAs and ZnTe AT 1,06 MICRONS. Sam, C. L. Providence, RI; Brown Univ. (1974). 120p. University Microfilms Order No. 75-9234.

Thesis (Ph. D.).

The fluctuation theory of ultrashort pulse (USP) generation in a Nd:glass laser with a saturable absorber, according to Letokhov, is outlined. When the lasing threshold is reached, many ultrashort fluctuation spikes grow independently of one another, until the strongest spike acquires sufficient intensity to saturate and bleach the absorber. The fast relaxation of the absorber precludes weaker spikes from passing through while it is still in the bleached state. The strongest spikes then experience a non-linear growth and evolve into the output pulse train, until the population inversion in the active medium is fully depleted. Thus one can distinquish a "linear" region $tau_1$ and a "non-linear" region $tau_2$ in the USP development. From this theory, a linear relationship between and the final pulse-width tau/sub p/ of the output USP train is predicted. An experiment is designed to determine the relationship between tau/sub p/ and $tau_1$. Laser damage experiments on GaAs and ZnTe with passively Q-switched nanosecond pulses and mode-locked picosecond pulse trains at 1,06mu are carried out. We find that the entrance surface damage threshold power density in the nanosecond case is smaller by a factor of approximately $10^2$ than the picosecond case for both materials. Other damage characteristics in the two time regimes are very similar. These observations indicate that electron avalanche breakdown is the dominant damage mechanism. The rear surface of GaAs is not damaged in both experiments. This leads one to speculate that the multiphoton absorption coefficients at these high incident intensities are larger than those measured at lower power densities. The morphologies of damage sites are in general in agreement with other published works. (Diss. Abstr. Int., B)

**27856** STABILIZATION OF A MODE-LOCKED Nd:GLASS LASER BY INTRACAVITY SECOND-HARMONIC GENERATION. Weisman, R. B.; Rice, S. A. (Univ. of Chicago). Spectrosc. Lett.; 8: No. 5, 329-340(1975).

A method is described for generating stabilized, intensity-limited pulse-trains from a mode-locked Nd:glass laser with internal second-harmonic generation. (auth)

**27857** CHEMISTRY IN LASERS. IX. A Re-examination of the Einstein Coefficients and Two Level Population Inversion. Keszthelyi, C. P. (Louisiana State Univ., Baton Rouge). Spectrosc. Lett.; 8: No. 5, 341-348(1975).

From a re-examination of the Einstein coefficients in terms of current theory the common assumption that population inversion cannot be maintained in a two level system by optical pumping is shown to be erroneous. The nonisotropy of the radiative ensemble in an optical resonant cavity, absent from the original derivation by Einstein, is shown to be of decisive importance. (auth)

**27858** AUTOMATIC REGULATION SYSTEM OF GAS PRESSURE IN ARGON LASER. Adamowicz, T.; Jonak, S.; Kruszewski, J.; Spytkowski, W.; Wolinski, W.; Zajac, C. (Polytechnic Inst. of Electron Technology, Warsaw). Elektronika; 16: No. 5, 206-207(1975). (In Polish).

The operation and construction of gas lasers are discussed and the parameters of an automatic system for regulating the pressure in an argon laser are described. (auth)

**27859** HYDROCARBON–AIR MIXTURE COMBUSTION GASODYNAMIC LASER. Kozlov, G. I.; Ivanov, V. N.; Korablev, A. S.; Selezneva, K. K. (Inst. of Problems in Mechanics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1647-1663(May 1975). (In Russian).

Results are presented of an experimental and theoretical investigation of the magnitude of the unsaturated amplification coefficient and power of laser radiation from a quasicontinuous gasodynamic laser operating on the products of combustion of hydrocarbon-air mixtures. Acetylene and propane air mixtures and a mixture of carbon monoxide and hydrogen were used. At optimal amplification values of the parameters ($p_0$ = 5–10 atm., $T_0$ = 1400 to 1700°K) the amplification coefficient was $8.10^{-3}$ $cm^{-1}$ which is in good agreement with the calculations. The maximal power generated was 8.5 kW. (auth)

**27860** EXPERIMENTAL INVESTIGATION OF COLLISION EXPANSION AND SHIFT IN THE LINE OF GENERATION FROM A MERCURY LASER DUE TO He AND Ne PRESSURE. Bikmukhametov, K. A.; Klement'ev, V. M.; Chebotaev, V. P. (Inst. of Semiconductors Physics, Novosibirsk, USSR). Kvantovaya Elektron.; 2: No. 3, 489-495(Mar 1975). (In Russian).

The results are discussed from experimental investigations on the impact expansion and shift in the line of generation from mercury on the junction $6p'\ ^3P_2^0 \rightarrow 7s^3S_1$ ($\lambda$ = 1.53 $\mu$m) as a function of helium and neon pressure. It was established that expansion of the mercury line as a function of pressure of helium is equal to 16 MHz/mm Hg and on the pressure of neon 10.5 MHz/mm Hg. From direct measurements it was found that the line shift takes place to the violet side of the spectrum and as a function of the helium pressure is equal to 1.8 MHz/mm Hg, and as a function of neon pressure 1.2 MHz/mm Hg. Comparison of the interactions of Hg-He and Hg-Ne showed that in both cases they have the same character and are described by the Leonard-Jones potential. By simultaneously measuring the expansion and shift in the line the size of the phenomenological constants $C_6$ and $C_{12}$ were determined; their order of magnitude is found to be in agreement with data from impact theory. An evaluation was made of the lifetime of the level $6p'\ ^3P_2^0$ which is found to be equal to about $2 \times 10^{-7}$ sec. (JPRS)

**27861** SPATIAL HETEROGENEITY OF INVERSION AND NON-DAMPING PULSATIONS IN SOLID-BODY LASERS. Antsiferov, V. V.; Gayner, A. V.; Komarov, K. P.; Folin, K. G. (Inst. of Physical Problems, Novosibirsk, USSR). Kvantovaya Elektron.; 2: 591-598(Mar 1975). (In Russian).

An analogy is suggested between the generation from a solid-body laser and the motion of a particle with friction in a potential well. Using this analogy it is shown analytically that a system of balanced equations does not describe the mode of non-damping pulsations by allowing only for spatial heterogeneity. It is established that such a heterogeneity sharply increases the critical nature of the generation toward perturbations of the real resonator. On the basis of comparing the results with experimental data, the existence of a mechanism was suggested which produces a mode of non-damping pulsations not associated with laser instabilities. (JPRS)

**27862** SPECTRAL CHARACTERISTICS OF A YAG:$Nd^{3+}$ SOLID-STATE CONTINUOUS RING LASER. Klochan, E. L.; Kornienko, L. S.; Kravtsov, N. V.; Lariontsev, E. G.; Shelayev, A. N. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 19: No. 10, 58-64(Oct 1974).

Translated from Radiotekh. Elektron.; 19: No. 10, 2096-2104(Oct 1974).

A theoretical and experimental study has been made of the spectral characteristics of a YAG:$Nd^{3+}$ solid-state ring laser. It is shown that one of the principal factors determining the width of the lasing spectrum is the coupling between opposite waves through backscattering. The dependence of the spectral characteristics on lasing conditions (standing-wave, unidirectional lasing, self-modulation and beats) is investigated. A narrowing of the radiation spectrum to a single mode was obtained in a rotating ring laser when the rotational velocity was increased. In a stationary ring laser single-mode lasing was obtained for self-modulation of the intensities of the opposite waves. (auth)

**27863** KRANTOVAIA ELEKTRONIKA I LAZERNAIA SPEKTROSKOPIIA. (Quantum Electronics and Laser Spectroscopy). Samson, A. M. Minsk; Izdatel'stvo Nauka i Tekhnika (1974). 512p.

The present work first examines the main characteristics of solid-state, liquid, and gas lasers and means of controlling the parameters of their radiation, and then describes their application for the diagnosis of physical objects. A model of an organic dye laser with continuous tuning in the near infrared and visible range is described. A new theoretical method is proposed for analyzing the high-frequency self-modulation of radiation when a transmission filter or nonlinear delay element is placed in the laser cavity. A section is devoted to the study of the effect of thermal stresses of the active rod on emission properties. The effect of rotational relaxation on the operation of a molecular laser in Q-switched regime is studied. Methods are described for achieving polarization-frequency independence and emission at various kinds of oscillations in ring lasers. The characteristics of the absorption of laser radiation in a low-

temperature plasma are studied. Much attention is then given to the use of lasers in spectral analysis and atmospheric sounding. (IAA)

**27864** DECREASE IN COMPETITION WITH INCREASING NUMBER OF MODES IN A GAS LASER. Aeiger, S. G.; Peliukhova, E. B. Opt. Spektrosk.:, 38: 134-140(Jan 1975).

The stability of steady modes in a collimated ring laser is analyzed for the case where the frequencies of five longitudinal modes are symmetrically spaced. Increase in pumping power leads to the appearance of additional pairs of longitudinal modes, the gain increasing with the appearance of each pair of modes. All the resonator frequencies are present in the lasing spectrum. The decrease in mode competition is attributed to self-locking of laser modes, leading to an increase in intensity of stimulated emission. (IAA)

**27865** HANLE CASCADE EFFECT AT THE 5 3D3 – 5 3P2 TRANSITION OF CADMIUM. Boiarskii, K. K.; Kotikov, E. N. (Leningrad State Univ.). Kvantovaya Elektron. (Moscow); 2: 23-27(Jan 1975). (In Russian).

A level traversing signal in a zero magnetic field was observed in the spontaneous emission at the 361-micron wavelength, from the working levels of a pulsed CdI laser. The shape of the signal was close to the difference of two Lorentz profiles, one of which is generated by the decay of the upper, and the other by the decay of the lower laser level. The radiative lifetimes and cross-sections of the depolarizing collisions between these levels and the neon buffer gas are identified. (IAA)

**27866** PUMPING SYSTEM FOR DYES WITH A U-SHAPED LAMP AND AN ACTIVE ELEMENT OF RECTANGULAR CROSS-SECTION. Anikiev, I. G.; Vdovchenko, R. G.; Telepin, S. N. Kvantovaya Elektron. (Moscow); 2: 7-12(Jan 1975). (In Russian).

A pumping system developed for rhodamine-6G, employing low-inductance flash lamps is discussed. The efficiency of the lamps is analyzed in various spectral regions. Illuminator efficiency is determined from the increase in volume of the active fluid. Means of increasing illuminator efficiency are proposed, and some experimental results obtained with the pumping system are discussed. (IAA)

**27867** SPECTRAL CHARACTERISTICS OF CHROMIUM-ACTIVATED YTTRIUM – ALUMINUM GARNET IN THE R-LINE REGION. Volkov, S. I.; Pasternak, L. B.; Sevast'ianov, B. K. (Inst. of Crystallography, Moscow). Kvantovaya Elektron. (Moscow); 2: 18-22(Jan 1975). (In Russian).

The luminescence and absorption spectra of yttrium-aluminum garnet crystals doped with Cr(3+) ions are studied (for both the ground and excited states of the crystals) at wavelengths of stimulated transition. The dependence of the threshold population of a metastable level on the spectral losses and on the lasing frequency is examined. It is shown that laser action at chromium ions in such crystals can be obtained only at low temperatures. (IAA)

**27868** EFFECT OF OXYGEN ON THE AVERAGE POWER OF SEALED-OFF TEA $CO_2$-LASER. Petrova, M. D. (Inst. of Electronics, Sofia). Bulg. J. Phys.; 11: No. 1, 74-78(1975).

The addition of oxygen to a sealed-off TEA $CO_2 - N_2$ laser, using pin-bar electrode configuration with low repetition rate has been found to increase the average power as much as a factor of two. Similar to the effect of helium on the discharge of this type of laser, oxygen leads to a more uniform discharge, decreases the decomposition of $CO_2$ and can increase its life. (auth)

**27869** TIME BEHAVIORS OF THE LASER PULSE OF TEA $CO_2$-LASER IN PURE $CO_2$ AND IN PRESENCE OF HYDROGEN AND NITROGEN. Stefanov, V. I.; Petrova, M. D. (Inst. of Electronics, Sofia). Bulg. J. Phys.; 11: No. 1, 67-73(1975).

The change of the shape of the laser pulse of TEA $CO_2$-laser was found by using pin-bar electrode configuration in pure $CO_2$ and in the presence of $H_2$ and $N_2$ and varying the pressure of $CO_2$. The time behaviors of the laser pulse indicate, that by excitation through 5 $\mu$s current pulses ($\tau_i$ $10^{-6}$s) two processes of excitation of $CO_2$ molecules exist simultaneously, that is the electron impact and the collisions of second kind between the molecules of $CO_2$, $H_2$ and $N_2$. Because of its fastness the electron excitation process dominates over the other processes. Hydrogen and nitrogen have effect on the lower and upper laser levels. The more uniform discharge and better pulse to pulse reproducibility result from the addition of $H_2$ and $N_2$ and the pressure of $CO_2$ can be increased from 90 to 150 torr without arcing. (auth)

**27870** COHERENCE STUDY OF A CW Nd:YAG LASER AND ITS SECOND-HARMONIC. Hori, K. I.; Bamba, Y.; Furuya, T. (Fujitsu Labs., Ltd., Kawasaki, Japan). Fujitsu Sci. Tech. J.; 10: 173-191(Dec 1974).

A description of a method for measuring cw Nd:YAG laser fundamental frequency and its second-harmonic using a rapid computation of the fringe visibility in a interferometer illuminated by the laser is given. The temporal coherence characteristics of the laser are given and discussed along with the calculated results of the fringe visibility. Measuring the fringe visibility as a function of the path-length difference of two beams has given excellent result in assessing the degree of coherence. The coherence length for the second-harmonic and the output power are shown to be insufficient for holography applications. (IAA)

**27871** GENERATION OF A SINGLE TUNABLE ULTRASHORT LIGHT PULSE. Schmidt, A. J. (Univ. of California, Berkeley). Opt. Commun.; 14: No. 3, 287-289(Jul 1975).

A novel system for generating single tunable ultrashort light pulses of high power is described. The pulse train from a mode-locked flashlamp pumped dye laser passes through an amplifier, which is pumped by an $N_2$ laser. As gain is only available for a few nsec, only one pulse in the train gets amplified. The energy of the resulting single pulse is about 100 mu J. (auth)

**27872** EMISSION AT THE SECOND HARMONIC IN A SEMICONDUCTOR INJECTION LASER. Vvedenskii, B. S.; Loginov, A. S.; Nikolaev, V. D.; Senatorov, K. Ya. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 15: 738-740(1974). (In Russian).

Experimental results in second harmonic excitation in alpha-$HIO_3$ crystals in heterojunction semiconductor injection lasers are reported. Diodes having several distinct, bright emission channels yielded a markedly stronger harmonic than diodes with relatively uniform emission at the p-n junction. The dependence of second harmonic intensity on the linear magnification coefficient of the focusing lens had a distinct maximum. It was shown that the spectrum of the harmonic does not have a markedly discrete structure. (IAA)

**27873** FREQUENCY SWEEP IN A LASER WITH ACTIVE NEGATIVE FEEDBACK. Makogon, M. M.; Serdiukov, V. I. (Inst. Optical Atmosfere, Tomsk, USSR). Kvantovaya Elektron. (Moscow); 2: 135-138(1975). (In Russian).

The application of an interferometer employing a piezoceramic element to the frequency control of a ruby laser using an active element with Brewster faces. The observed appreciable decrease in frequency jumps during sweeping (as compared to the free lasing mode) is attributed to the elimination of nonuniform inversion by active negative feedback. (IAA)

**27874** INVESTIGATION OF A GAS LASER BASED ON VAPORS OF YTTERBIUM. Klimkin, V. M. (Inst. of Optics of the Atmosphere, Novosibirsk, USSR). Kvantovaya Elektron.; 2: No. 3, 579-584(Mar 1975). (In Russian).

An investigation was conducted on the conditions of excitation and the energy and time parameters of a number of generation lines in vapors of ytterbium. The features were determined for the position of the laser transitions in the spectrum of ytterbium and mechanisms were proposed for creating inversion in the structure of the first excited states of an atom of ytterbium. Generation was produced on six new lines. (JPRS)

**27875** SINGLE-FREQUENCY LASER BASED ON NEODYMIUM GLASS OPERATING IN A MODE OF QUALITY MODULATION. Egorov, A. L.; Korobkin, V. V.; Serov, R. V. (Lebedev Inst. of Physics, Moscow). Kvantovaya Elektron.; 2: No. 3, 513-518(Mar 1975). (In Russian).

A reliable generation from a neodymium laser on one longitudinal and basic transverse mode in a mode of modulated quality is achieved by using a specially constructed resonance reflector – a selector of longitudinal modes – as the output mirror. The computation method for the selector and the characteristics of the single-frequency laser are given. (JPRS)

**27876** INFLUENCE OF DEUTERIUM ON OPERATION OF A TEA CARBON DIOXIDE LASER. Al'brekht, Kh.; Bespalov, V. A.; Platonenko, V. T. Zh. Eksp. Teor. Fiz., Pis'ma Red.; 21: No. 1, 74-77(1975). (In Russian).

Experiments are described which show that deuterium dopants appreciably improve the working characteristics of mixtures in a carbon dioxide laser. When mixtures containing nitrogen are used, deuterium doping increases the output energy of the laser by 20%. In the case of mixtures which do not contain nitrogen, substitution of deuterium for helium increases the output power by a factor of 3 to 4 with an insignificant change of pulse duration. (Ref. Zh.)

**27877** EFFECT OF $\gamma$ RADIATION ON $NaLa(MoO_4)_2 - Nd^{3+}$ LASERS. Bedilov, M. R.; Beisembaeva, Kh. B.; Egamov, U.; Gulyamov, U. G. (Inst. of Nuclear Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 20: No. 3, 506-508(Mar 1975). (In Russian).

The populating and emission characteristics of a $NaLa(MoO_4)_2 - Nd^{3+}$ laser were studied in the $^{60}Co$ $\gamma$ dose interval from 0 to $10^8$ R. An active element with a length of 52 mm and diameter of

5 mm was used in the tests. The laser characteristics before and after irradiation were studied by photoelectric, calorimetric, photographic, and spectrophotometric methods. It was experimentally established that the laser output is changed significantly with increase of the irradiation dose. The emission processes as a function of the number of flashes of the pumping lamp have a non-linear character. The change of the laser parameters after irradiation is caused by radiation processes occurring in the matrix of the active element of the laser. (tr-auth)

## Cryogenic and Superconducting Equipment and Devices

*Refer also to abstracts 27814, 28761, 28810, 28822–28835, 28904, 28931, and 28969.*

**27878** (KFTI-74-29) UTILIZATION OF WIRE CRYOTRON IN COMPUTING AND MEASURING DEVICES. Kan, Ya. S.; Rakhubovskij, V. A. (AN Ukrainskoj SSR. Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 21p. (In Russian). INIS.

The construction, principles of action, basic features, and the advantages and disadvantages of the wire cryotron are described. Discussions are presented of some of the components and the scheme of the calculating structures — memory element, code variants, decoder, shift register, combination single-charge totalizer, logic elements, and the designed and experimentally studied mock-ups of the calculational structures — digital computer with programming equation, multiplier structure, and calculational methods. The construction is based on a magneto-control contact, designed for output of information from the cryotron systems. The possibility is shown of using cryotrons in measurement equipment operating at helium temperatures — bridge amplifier and oscillation relaxation generator. (tr-auth)

**27879** (LBL-3222) SCMAG SERIES OF PROGRAMS FOR CALCULATING SUPERCONDUCTING DIPOLE AND QUADRUPOLE MAGNETS. Green, M. A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1974. Contract W-7405-Eng-48. 2p. (CONF-741001-61). Dep NTIS $4.00.

From CUBE symposium; Livermore, California, USA (23 Oct 1974).

Programs SCMAG1, SCMAG2, SCMAG3, and SCMAG4 are a group of programs used to design and calculate the characteristics of conductor dominated superconducting dipole and quadrupole magnets. These magnets are used to bend and focus beams of high energy particles and are being used to design the superconducting magnets for the LBL ESCAR accelerator. The four programs are briefly described. (TFD)

**27880** (LBL-3759) SUPERCONDUCTING JUNCTION BOLOMETERS. Hoffer, G. I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 102p. Dep. NTIS $8.25.

Thesis.

A composite bolometer was developed in which the temperature-sensing element was a superconducting junction, the radiation absorber was a thin film of bismuth, and the support substrate was a piece of sapphire. Two types of junction were used: the superconductor-normal metal-superconductor (SNS) junction and the superconductor-insulator-normal metal (SIN) junction. The performance of these bolometers was measured and compared with that calculated from fundamental noise limits. Near-ideal performance was achieved with the SNS bolometers, and the best electrical NEP (noise equivalent power) observed was $5 \times 10^{-15}$ W/rootHz. The sensitivity of the SIN bolometers was limited by amplifier noise, but use of the best available amplifier combined with an impedance-matching device at cryogenic temperatures might provide performance comparable with that of the SNS bolometers. The absorption of infrared radiation by bismuth films of various thicknesses on sapphire substrates was measured over the frequency range 3 to 300 $cm^{-1}$ using a Fourier-transform Michelson interferometer. The results were found to be in good agreement with theoretical calculations. Fabry-Perot fringes appeared in the absorption spectra due to interference between reflections from the two faces of the sapphire substrate. The maximum average total absorption observed for the sapphire-bismuth composites was 58 percent. (auth)

**27881** (RL-75-061) PRESSURE IMPREGNATED SUPERCONDUCTING DIPOLE. Wilson, M. N.; Hopes, R. B.; Roberts, R. L. (Science Research Council, Chilton (UK). Rutherford Lab.). 1975. 9p. (CONF-750438-6). Dep. NTIS (US Sales Only) $4.00.

From fifth international conference on magnet technology; Frascati, Italy (21 Apr 1975).

A superconducting dipole is being constructed using a new high pressure impregnation technique. The windings will be enclosed in a strong pressure vessel and impregnated, at a pressure of about 35 MN $m^{-2}$ with an epoxy resin which will subsequently be cured at that pressure. In this way it is hoped to reduce training, presuming this to be caused by conductor movement and resin fracture under the action of magnetic stress. No test results of the magnet are reported. (auth)

**27882** EVALUATION OF LAYERED NIOBIUM-TIN ($Nb_3Sn$) CONDUCTOR. Schwall, R. E.; Howard, R. E.; Zubeck, R. B. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Magn.; MAG-11: No. 2, 397-400(1975).

Considerable progress made in developing a low-loss superconductor for use in a 60 Hz a.c. power transmission line, and especially work by Snowden et al. (1974) indicated the possibility of exploiting conductor configurations attainable by thin-film evaporation techniques to achieve critical currents and a.c. loss characteristics superior to that of bulk materials. An instrumentation which was designed to test conductors fabricated by the evaporation technique is described and preliminary results on these materials are presented. (auth)

**27883** POTENTIAL CONDUCTORS FOR A DC SUPERCONDUCTING POWER TRANSMISSION LINE IN A 20-METER TEST BED. Hoffer, J. K. (Los Alamos Scientific Lab., NM). IEEE (Inst. Electr. Electron. Eng.) Trans. Magn.; MAG-11: No. 2, 385-388(1975).

The cryogenic and electrical aspects of a program to evaluate superconductors for a d.c. superconducting power transmission line are presented. Results for 20-m long conductors operated at less than or equal to 10 kA are described. A battery driven power supply which is capable of delivering and controlling these currents is discussed. Specific experiments are discussed which were designed to probe the response of the conductors to a variety of thermal and electrical conditions, such as: thermal gradients over the length of the conductor, single and 2-phase flow of cryogen, loss of coolant flow, operation around critical temperature, a.c. ripple current, and high current ramping rates. (auth)

**27884** CIRCUITS TO MEASURE ALIGNMENTS IN TUNNEL JUNCTIONS. Will, T. A.; Heirass A, J. L. (Universidad Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 23: FA39-FA50(1974). (In Spanish).

In order to extract information available in superconductive tunneling concerning the electron and phonon densities of states as well as the electron-phonon interaction, it is necessary to measure with high precision the derivatives of the tunneling current. A conductance bridge is combined with a modulation technique to provide adequate precision; its over-all sensitivity is two parts in $10^5$. (auth)

**27885** CHARACTERISTICS OF THE JOSEPHSON TRIODE. Likharev, K. K. Radiotekhnika (Moscow); No. 3, 660-662(1975). (In Russian).

Since only the junctions formed by the contact of the two superconductive elements in which the Josephson effect occurs have been considered up until now, the purpose of this paper is to explain the new characteristics that arise when three superconductive electrodes participate in the Josephson interaction. This Josephson triode is examined theoretically, starting from the assumption that the applicability conditions of the Aslamazov-Larkin theory are satisfied. Equations are obtained which show that the equivalent circuit of the Josephson triode is in the form of a triangular connection of the individual Josephson junctions between electrodes. A drawing of this equivalent circuit is given together with its suggested structure. From equations developed for the resistive model, the theoretical volt-ampere characteristic of the triode is plotted. A possible application of the triode is proposed. (JPRS)

**27886** REPULSION MAGNETIC SUSPENSION RESEARCH: US PROGRESS TO DATE. Borcherts, R. H. (Ford Motor Co., Dearborn, MI). Cryogenics; 15: No. 7, 385-393(Jul 1975).

Eight years of US progress in repulsion magnetic suspension is outlined, particularly those programs supported by the US Department of Transportation. Discussion starts with the small scale laboratory experiments measuring the lift and drag forces on superconducting coils, continues through measurement of cryogenic losses, superconducting parametric studies, ride predictions, and concludes with a summary of the recently completed conceptual vehicle design and system study. (auth)

**27887** MAGNEPLANE SYSTEM. Kolm, H. H.; Thornton, R. D.; Twasa, Y.; Brown, W. S. (Massachusetts Inst. of Tech., Cambridge). Cryogenics; 15: No. 7, 377-384(Jul 1975).

The results of the magneplane project carried out by a joint MIT-Raytheon-United Engineers team are summarized. These include preliminary design of a full-scale system with analysis of guideway and power distribution costs, vehicle requirements, and vehicle dynamics. The theoretical results were tested prac-

tically by building a fully operational 1/21 scale model system using both samarium-cobalt and superconducting magnet vehicles with on-board control telemetering systems, operating on a 116 m long actively synchronized guideway. The construction and testing of this scale model is also described. (auth)

**27888** WOLFSON MAGNETIC LEVITATION PROJECT. Rhodes, R. G.; Mulhall, B. E. (Warwick Univ., Coventry, Eng.). Cryogenics; 15: No. 7, 403-405(Jul 1975).

The Wolfson magnetic levitation project is concerned with the construction of a 500 m long test track and vehicle, levitated electrodynamically by means of superconducting magnets. The general design features and present status of the project are described. The particular aspects which are discussed include the guideway design, the cryogenic system and superconducting coils, and both the linear synchronous and commutator motor propulsion systems having powered track windings. (auth)

**27889** DEVELOPMENT OF SUPERCONDUCTING LEVITATED TRAINS IN JAPAN. Kyotani, Y. (Japanese National Railways, Tokyo). Cryogenics; 15: No. 7, 372-376(Jul 1975).

For the development of superconducting levitated trains in Japan, high speed, low public nuisance, and easy maintenance are required in addition to the advantages of the conventional railway. Basic experiments by a rotational test device and running tests on the 220 m and 480 m length test track have been conducted. A 7 km test track is to be built to check the feasibility of superconducting levitation and linear synchronous motor propulsion up to 50 km $h^{-1}$. Tests on this track are scheduled to commence in the spring of 1977. (auth)

**27890** CANADIAN DEVELOPMENTS IN SUPERCONDUCTING MAGLEV AND LINEAR SYNCHRONOUS MOTORS. Atherton, D. L.; Eastham, A. R. Cryogenics; 15: No. 7, 395-402(Jul 1975).

Canadian developments in the application of superconducting magnets for levitation, synchronous propulsion, and guidance of high speed intercity ground transport are described. At 480 km $h^{-1}$ a 100 passenger vehicle weighing 300 kN is levitated 15 cm clear of a flat guideway (minimizing ice and snow accumulation) by eight $3.85 \times 10^5$ ampere-turns $100 \times 30$ cm magnets interacting with eddy currents induced in two $80 \times 1$ cm aluminum strips. The variable speed LSM uses fifty $5 \times 10^5$ ampere-turns $40 \times 150$ cm magnets interacting with split three-phase windings energized in 5 km sections and phase angle controlled to give 72% efficiency and 0.82 power factor. A lateral restoring force of $10^4$ N $cm^{-1}$ is produced by the propulsion magnets interacting with the levitation strip edges and with flat null-flux loops overlying the LSM windings. A review of cryogenic systems indicates that isochoric dewar operation is best suited for Maglev vehicles. The test facility, using stationary full-scale superconducting magnets and guideway components mounted on a 100 km $h^{-1}$ vertical axis 7.6 m dia wheel, is now fully operational and LSM tests are being performed. (auth)

**27891** INVESTIGATIONS ON POTENTIAL CONDUCTORS FOR A DC SUPERCONDUCTING POWER TRANSMISSION LINE IN A 20 METER TEST BED. Hoffer, J. K. (Los Alamos Scientific Lab., NM). IEEE (Inst. Electr. Electron. Eng.) Trans. Magn.; MAG-11: No. 2, 385-388(Mar 1975).

The cryogenic and electrical aspects of a program to evaluate superconductors for a dc superconducting power transmission line are presented. Results for conductors in lengths of 20 meters operated at currents up to 10 kA are described. A battery driven power supply which is capable of delivering and controlling currents up to 50 kA is discussed. Specific experiments are discussed which have been designed to probe the response of the conductors to a variety of thermal and electrical conditions, such as: thermal gradients over the length of the conductor, single and two phase flow of cryogen, loss of coolant flow, operation at temperatures near T/sub c/, ac ripple current, and high current ramping rates. (auth)

**27892** DILUTION REFRIGERATOR WITH SUPERFLUID INJECTION. Staas, F. A.; Severijns, A. P.; van der Waerden, H. C. M. (Philips Gloeilampenfabrieken N.V., Eindhoven (Netherlands)). Phys. Lett., A; 53: No. 4, 327-328(30 Jun 1975).

In a conventional dilution refrigerator an additional $^4$He loop is incorporated. As a result the cooling power has been increased by at least one order of magnitude. (auth)

**27893** SHORT SAMPLE TEST OF SUPERCONDUCTING WIRE. Price, M. E.; Yamada, R. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1190-1193(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Two different techniques were used for short sample tests of superconducting wires. One method was done with a dc transformer and the other with a high current dc power supply. Three different types of sample holders were used for the latter, and their relative merits are compared. Many wire designs, representing half a dozen companies, were tested, and their results are presented. For the short sample test, quench current and current at various resistivities were determined. Resistivity ratios of rho/sub 300// rho/sub 12/ were found for copper, and the effect of cold work on these ratios was investigated. (auth)

**27894** DISTRIBUTION OF THE NORMAL AND SUPERCONDUCTING PHASES IN THE INTERMEDIATE STATE OF A CURRENT-CARRYING SUPERCONDUCTING CYLINDER. Freud, R. (Hessensgade 12, 2300 Copenhagen S, Denmark). Physica; 79: No. 3, 230-242(1975).

The relative content of the normal and superconducting phases inside the core of a current-carrying superconducting cylinder in the intermediate state is determined from the experimental distribution of the magnetic induction inside the cylinder, the resistance jump at the transition from the superconducting to the intermediate state, the resistance curve, and the values of the core radius. Then it appears that the formula for the relative content of the normal phase inside the core $n(r/r_0) = (r/r_0)^{\frac{1}{2}}$ leads without any additional assumption to reasonable agreement with experiment, where r and $r_0$ are the distances from the core axis and the core radius, respectively. (auth)

## Heat Transfer and Fluid Flow

*Refer also to abstract 30430.*

**27895** (ZJE-165) SOLVING THREE-DIMENSIONAL TEMPERATURE FIELD BY MEANS OF FINITE ELEMENT METHOD. Sik, J. (Skoda, Plzen (Czechoslovakia). Zavod Jaderne Elektrarny). 1975. 18p. Dep. NTIS (US Sales Only) $4.00.

The principles of the finite element method for solving problems associated with the conduction of heat and its application in solving a three-dimensional stationary temperature field with generation of heat are presented. A block diagram of the program and the results obtained for a particular case are also given. (auth)

**27896** RATES OF ATOMIZATION AND DROP SIZE IN ANNULAR TWO-PHASE FLOW. Tatterson, D. F. Urbana, IL; Univ. of Illinois (1975). 284p. University Microfilms Order No. 75-14,180.

Thesis (Ph. D.).

The process of atomization and the subsequent drop size distribution produced in the annular two-phase flow regime is discussed. A model is developed from which correlations are developed for the rate of atomization and the resulting parameters in the drop size distribution. Atomization in the annular two-phase flow regime occurs by the removal of small wavelets from the top of roll waves. The model proposes approximating the roll waves by a square wave train and the atomizing wavelets on top of the roll waves by a sinusoidal wave train. Based on this physically simplified picture a correlation for the rate of atomization, which contains two factors, is developed. The first factor, an intermittency factor which arises because the entire surface is not covered by atomizing waves, appears to be approximately constant for sufficiently large film flow rates. The second factor arises from an analysis of the rate of atomization from one square wave. In developing this factor a modified Taylor analysis is used to describe the growth rate of wavelets. Based on the physical picture of atomization via ligament formation presented by Woodmansee and the fact that the diameter of drops produced by the break-up of a ligament are directly proportional to the ligament diameter, a mathematical analysis is presented and it is suggested that the drop size distribution produced by the atomization process is upperlimit lognormal, a three parameter distribution. Data from the literature and data taken by this experimenter indicate that a reasonable fit of the data can be obtained using this distribution function. Methods are suggested to correlate the three parameters in the distribution and these methods are evaluated in terms of available data. An electronic technique was also used to try to measure drop size. The method is based on charging a drop surface to a high voltage, which causes a pulse in the external circuit. It has been found that the pulse height is proportional to the drop diameter squared. Electronic equipment has been designed to analyze the signal. However, due to experimental problems, it cannot be recommended at this time that this technique be used to measure drop size distributions in annular two-phase flow. (Diss. Abstr. Int., B)

**27897** COOLING SYSTEM FOR DISCHARGE OF PROCESS HEAT INTO THE AIR WITHOUT EVAPORATION. Rieger, A. (to Kraftwerk Union AG). German (FRG) Patent 2,349,483/S/. 3 Apr 1975. 9p.( (In German).

The layout of a dry cooling system is described. Bursting electrodes generate an ion current between the heat exchanger tubes and the brushing electrodes. This current excites the boundary layer between tubes and cooling air and thus improves the heat transfer. (RW/AK)

**27898** DETERMINATION OF CONDITIONS CORRESPONDING TO THE INCEPTION OF UNSTABLE FILM BOILING. Ornatskii, A. P.; Chernobai, V. A.; Savina, V. N. Fluid Mech. - Sov. Res.; 2: No. 3, 149-153(1973).

Results of experiments conducted with water, antifreeze 65, and ethylene glycol to correlate four different parameters used as criteria for evaluation of the critical heat-flux density, $q_{cr}$ (inception of change of nucleate to film boiling) are reported. The purpose was to clear up discrepancies in previously reported data by others. Experimental apparatus is described but not illustrated. The range of variables was: mass flowrate—1000 to 5000 kg/m$^2$-sec; pressure—1.08 to 4.9 bars; average coolant temperature: 30 to 100°C; subcooling: 10 to 110°C for water 30 to 140°C for antifreeze 65, and 60 to 220°C for ethylene glycol. The four means of detecting $q_{cr}$ were: (1) jump in the wall temperature variation with $q_{cr}$, (2) maximization of heat transfer coefficient, (3) maximization of acoustic frequency values, and (4) visually—onset of local reddening of the heat-transfer surface. Results are plotted showing that the first three methods are in good agreement, but that the fourth (onset of local reddening) gives values of $q_{cr}$ 50 to 100% greater than the others. (Appl. Mech. Rev.)

**27899** POST-DRYOUT HEAT TRANSFER: PHYSICAL MECHANISMS AND A SURVEY OF PREDICTION METHODS. Groeneveld, D. C. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Nucl. Eng. Des.; 32: No. 3, 283-294(1975).

92 refs.

Significant thermal non-equilibrium has been observed in the post-dryout regime. The degree of thermal non-equilibrium depends primarily on liquid-vapor interaction, and the heated surface temperature is controlled by the near-wall vapor velocity, vapor superheat and liquid-wall interaction. The possible mechanisms of post-dryout heat transfer and the state of the art for predicting post-dryout temperatures are described. The semi-theoretical approach is the most promising for simple geometries. Four empirical methods of predicting post-dryout temperatures are discussed. A bibliography and a table of all known post-dryout heat transfer correlations are presented. (auth)

**27900** ON THE DYNAMICS OF NUCLEATE REGION POOL BOILING. Peterson, W. C. (North Carolina State Univ., Raleigh (USA)); Zaalouk, M. G. (Carolina Power and Light Co., Raleigh, N. C. (USA)); Gueceri, S. I. (North Carolina State Univ., Raleigh (USA). Dept. of Mechanical and Aerospace Engineering). Nucl. Eng. Des.; 32: No. 3, 295-301(1975).

A transfer function to describe pool boiling dynamics was previously developed analytically. Dynamic measurements were performed and a transfer function for nucleate boiling was obtained based on experimental results. The transfer function contained an exponential delay term and for this reason was in many cases inconvenient to use. It has recently been found possible to represent the experimental results by a transfer function containing only finite zeros and poles and no exponential delay term. The new transfer function presented is considered to be an improvement. (auth)

## Materials Testing

*Refer also to abstract 28505.*

**27901** SCINTILLOGRAPHY USING THERMAL NEUTRONS. Sinclair, K. F.; Zagorites, H. A. (Xetex, Inc., Redwood City, CA). Mater. Eval.; 33: 56-60(Mar 1975).

From American Society for Nondestructive Testing, National Fall Conference; Chicago, IL (1 Oct 1973).

The thermal neutron scintillography system for nondestructive evaluation is described, with particular reference to the radiation source, high-efficiency scintillation detection, suitable collimation, and electronic processing and readout. A block diagram of the system is provided, and the system performance factors are examined. A comparison between scintillography and radiography reveals that the sensitivity of scintillography is quite competitive with film, and that scintillography offers the advantages of one-line inspection and an improved source utilization due to geometrical advantages of the system. Neutron sources and an application of neutron scintillography are presented. It is suggested that the technique is well suited for production-type tasks owing to low piece cost and ease of automating inspection procedure. (IAA)

## Nuclear Explosions

*Refer also to abstracts 27916, 27935, 28100, and 29994.*

**27902** (FOA-C-20016-D6-A3) FIRE DEVELOPMENT IN RESIDENTIAL ROOMS AFTER IGNITION FROM NUCLEAR EXPLOSIONS. Haegglund, B.; Jansson, R.; Onnermark, B. (Foersvarets Forskningsanstalt, Stockholm (Sweden)). Nov 1974. 30p. Dep. NTIS (US Sales Only) $4.50.

The purpose of the investigation was to improve the knowledge about the early phases of fire development in residential rooms after ignition by thermal radiation from nuclear explosions. Experimental results concerning the time from the irradiation to the beginning of the flame phase, the duration of the flame phase and the maximal burning rate are given for different kinds of upholstered furniture and similar fuels. Results are given concerning the relationship between burning rate, fire ventilation and the occurrence of flashover in a small residential room with incombustible surfaces. The knowledge gained results in a method for roughly predicting if a flashover is possible in a room, considering the amount and kind of fuel available. (auth)

**27903** (JAB-99-118) STATISTICAL STUDY ON THE STRENGTH OF STRUCTURAL MATERIALS AND ELEMENTS. Blume, J. A.; Dalal, J. S.; Honda, K. K. (Blume (John A.) and Associates, Engineers, San Francisco, Calif. (USA)). Jul 1975. Contract AT(26-1)-99. vp. Dep. NTIS $5.45.

Strength data for structural materials and elements including concrete, reinforcing steel, structural steel, plywood elements, reinforced concrete beams, reinforced concrete columns, brick masonry elements, and concrete masonry walls were statistically analyzed. Sample statistics were computed for these data, and distribution parameters were derived for normal, lognormal, and Weibull distributions. Goodness-of-fit tests were performed on these distributions. Most data, except those for masonry elements, displayed fairly small dispersion. Dispersion in data for structural materials was generally found to be smaller than for structural elements. Lognormal and Weibull distributions displayed better overall fits to data than normal distribution, although either Weibull or lognormal distribution can be used to represent the data analyzed. (auth)

**27904** (NVO-155(Vol.2)) IN SITU LEACHING OF A NUCLEAR RUBBLIZED COPPER ORE BODY. Volume II. Detailed Design, Calculations, and Procedures. (Energy Research and Development Administration, Washington, D.C. (USA); Kennecott Copper Corp., Salt Lake City, Utah (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1975. 352p. Dep. NTIS $10.60.

Detailed descriptions of technical and economic evaluations are presented for a feasibility study on the use of nuclear explosive technology for exploitation of deep-lying copper deposits. The approach considered involves the emplacement of nuclear explosives below the water table in a deep-lying copper deposit. The explosives are detonated to rubblize the rock, then oxygen and water are passed through the rubblized zone to leach out the copper as copper sulfate. The copper sulfate is then brought to the surface where liquid ion exchange and electrowinning is used to remove the copper. (JGB)

**27905** (TMR-1) COMPARISON OF CALCULATED AND MEASURED CLOSE-IN GROUND MOTIONS FOR HARDHAT, SHOAL, AND PILEDRIVER. Cassity, C. R. (Environmental Research Corp., Alexandria, Va. (USA)). 25 Jan 1968. Contract AT(29-2)-1163. 10p. Dep. NTIS $4.00.

The underground nuclear detonations Hardhat, Shoal, and Piledriver were located in granite, a medium for which there are available a number of Hugoniot measurements. The Hugoniot measurements have been converted to a Hugoniot equation of state and this equation applied to solid material outside the gaseous material of the expanding vaporized cavity. Pressures within the cavity were calculated from an equation proposed by Tonks. Calculated cavity pressures initiate motions in a spherically symmetric one-dimensional mass-spring system which models the solid material. Calculated pressures and particle velocities within the mass-spring system may be compared with measured pressures and particle velocities to provide confirmation of the calculational procedure, alternatively, to indicate desirable changes therein. Such comparisons are made herein for the three events--Hardhat, Shoal, and Piledriver. (auth)

**27906** KERNWAFFEN UND AUSWAERTIGE POLITIK. (Nuclear Weapons and Foreign Policy). Kissinger, H. A. Schriften des Forschungsinstituts der Deutschen Gesellschaft fuer Auswaertige politik. Munich; Oldenbourg(1974). 420p.

With refs.

This book—originally published in 1957—is intended as a first step towards a change in the traditional concepts of war, diplo-

macy, and the nature of peace in the direction of a new theory which takes into account the risks and possibilities of the atomic age. Some concepts of thought are explained which may serve as a basis for foreign policy and strategy; some of the dangers of the traditional concept of safety are mentioned along with new possibilities–all in consideration of a world which was bipolar from a military and political point of view when this book was published. (GE)

**27907** GEOLOGY OF WAGON WHEEL NUCLEAR STIMULATION PROJECT, PINEDALE FIELD, WYOMING. Shaughnessy, J.; Butcher, R. H. (El Paso Natural Gas Co., TX). Amer. Ass. Petrol. Geol. Bull.; 58: No. 11, 2250-2259(Nov 1974).

Wagon Wheel is a project planned to stimulate a well in gas reservoirs of the Pinedale anticline by means of nuclear explosives. The Pinedale field, in the northern part of the Green River basin of southwest Wyoming, is potentially productive from almost 10,000 ft of lower Fort Union, Lance–Lewis, and Mesa Verde sandstones. Attempts to produce the field conventionally have proved uneconomic because of low permeability. Reserves in this field are calculated at 270 Bcf of gas in place per square mile. Plans call for sequential detonation of five explosives spaced at intervals from 9,220 to 11,570 ft, to produce a continuous chimney from 9,000 to 11,650 ft. There will be a safety martin of 1,600 ft between the top of fractures and the bottom of the known aquifers. (RCK)

## Protective Structures and Equipment

*Refer also to abstract 30404.*

**27908** STRAHLENSCHUTZTUEREN FUER MEDIZINISCH GENUTZTE RAEUME. Drehfluegeltueren, Einfluegelig Mit Richtzarge, Masse. (Radiation Protection Doors. Revolving Folding-Doors, Single Wing Doors, Dimensions). Berlin; Beuth (1973). 2p.

The standard applies to doors with a lead insert up to 20 mm or doors with an attenuation equivalent for x, gamma, and electron radiations. (GE)

**27909** STRAHLENSCHUTZTUEREN FUER MEDIZINISCH GENUTZTE RAEUME. Drehfluegeltueren, Zweifluegelig Mit Richtzarge, Masse. (Radiation Protection Doors. Revolving Folding-Doors, Double Wing Doors, Dimensions). Berlin; Beuth (1973). 2p.

The standard applies to doors with a lead insert up to 20 mm or doors with an attenuation equivalent for x, gamma, and electron radiations. (GE)

**27910** STRAHLENSCHUTZTUEREN FUER MEDIZINISCH GENUTZTE RAEUME. Schiebetueren, Einfluegelig, Masse. (Radiation Protection Doors. Sliding Doors, Single Wing Doors, Dimensions). Berlin; Beuth (1973). 2p.

The standard applies to doors with a lead insert up to 20 mm or doors with an attenuation equivalent for x, gamma, and electron radiations. (GE)

**27911** STRAHLENSCHUTZTUEREN FUER MEDIZINISCH GENUTZTE RAEUME. Schiebetueren, Zweifluegelig, Masse. (Radiation Protection Doors. Sliding Doors, Double Wing Doors, Dimensions). Berlin; Beuth (1973). 2p.

The standard applies to doors with a lead insert up to 20 mm or doors with an attenuation equivalent for x, gamma, and electron radiations. (GE)

**27912** STRAHLENSCHUTZTUEREN FUER MEDIZINISCH GENUTZTE RAEUME. Anforderungen. (Radiation Protection Doors. Requirements). Berlin; Beuth (1973). 3p.

The standard applies to doors with a lead insert up to 20 mm or doors with an attenuation equivalent for x, gamma, and electron radiations. (GE)

## Safety Engineering

*Refer also to abstract 28718.*

**27913** (ORNL-5055, pp 48-62) INDUSTRIAL SAFETY AND SPECIAL PROJECTS. Aug 1975.

In applied health physics and safety annual report for 1974. Progress report, 1974. (Oak Ridge National Lab., Tenn. (USA)).

There were five disabling injuries experienced by personnel at ORNL in 1974, a frequency rate of 0.81. The frequency rate for 1973 was 0.33. The serious injury frequency rate for 1974 was 4.9 as compared to a frequency rate of 5.8 for 1973. A total of 315 days were lost or charged for the five disabling injuries. No employee suffered any permanent disability. (auth)

## Vacuum Engineering

**27914** (SGAE-2201) CRYOSORPTION PUMPING AT 77°K FROM ATMOSPHERIC PRESSURE TO $10^{-7}$ TORR. Dobrozemsky, R.; Moraw, G. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). Dec 1973. 12p. (PH–154/73). INIS.

Two types of cryosorption pumps with pumping speeds for air of 60 liters/s (1.5 kg Zeolite 5A, 1/16'' pellets) and 165 liters/s (4.5 kg Zeolite 5A, 1/16'' pellets) have been constructed. A 10 liter vacuum system, evacuated by two cryosorption pumps (1.5 kg Zeolite each) was used to establish the optimum activation conditions. The final pressures and the residual gas compositions for various activation conditions are discussed. Our results demonstrate that final pressures in the $10^{-7}$ torr range can be attained (after a one-stage pre-evacuation from 760 to approx 1 torr by means of another cryosorption pump) if (1) the chilled pump is saturated with air prior to the activation process; (2) the vacuum system is rinsed effectively by the gas desorbed during the activation process; and (3) activation temperatures < 150°C are applied. (INIS)

# ENVIRONMENTAL AND EARTH SCIENCES

**27915** (COO-2483-10) CONNECTICUT SEISMIC NETWORK STUDIES. Technical Progress Report, 1 July 1974–30 June 1975. Chiburis, E. F. (Connecticut Univ., Groton (USA)). 1975. Contract AT(11-1)-2483. 10p. Dep. NTIS $4.00.

Data acquisition systems for the compilation of seismic data in Connecticut and Massachusetts during the period from July 1974 to July 1975 are discussed briefly. A list is included of earthquakes in New England from 1972 through Feb. 20, 1975. (CH)

**27916** (PNE-RB-68) PROJECT RIO BLANCO; INVESTIGATION FOR POSSIBLE DELAYED SEISMIC EFFECTS ON VEGETATION. Whicker, F. W. (Colorado State Univ., Fort Collins (USA). Dept. of Radiology and Radiation Biology). Aug 1975. 26p. Dep. NTIS $4.50.

For CER Geonuclear Corp., Las Vegas, NV.

An investigation to determine whether and to what extent ground motion from Project Rio Blanco might cause widespread damage to trees and shrubs through root shear, showed that such effects did not occur to any measurable extent. The only vegetative damage observed that could be attributed to ground motion was observed in localized topographic situations that would permit complete root system disruption, burial, or severe damage to aerial parts. Plant communities in the environs of Project Rio Blanco remain, for all practical purposes, and with exception of mechanically cleared areas, unchanged. (auth)

**27917** (SAND-75-0321) AUTOMATIC DIGITAL ACQUISITION SYSTEM FOR METEOROLOGICAL DATA. Rogers, M. S.; Aden, R. D.; Watterberg, J. P.; Van Meter, J. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Aug 1975. Contract AT(29-1)-789. 25p. Dep. NTIS $4.00.

A system was installed at Tonopah Test Range to facilitate the continuous automatic collection and display of meteorological data. All readings are converted to digital form to simplify transmission from remote areas and reduce noise interference, to permit easy data manipulation, and to provide a compatible interface for computer reduction of the data. (auth)

## Minerals and Ores

**27918** (ERDA-tr-57) CONTRIBUTION TO THE GEOCHEMISTRY OF URANIUM IN INTRUSIVE GRANITES. Coulomb, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Documentation). Jan 1959. Translation by I. A. Leonard of CEA-1173. 102p. Dep. NTIS $8.25.

The position is defined of a certain number of French granitic deposits within the field of the geochemistry of granites in general, and of the geochemistry of uranium in particular. The regions concerned are the French hercynian ranges, in the Vendée, in Brittany and in the Morvan, and the African range, probably precambrian, of the Hoggar. For each range the petrochemical framework is first of all determined and then the degree of chemical homogeneity of the rocks is evaluated. In the petrochemical groups thus obtained the geochemical behavior of the uranium is studied. From the viewpoint of the geochemistry of the granites under investigation, a comparison of the laws of distribution of the major elements in the ranges shows up a convergence of average composition which was not anticipated by geological and petrographic considerations alone. The statistical and geochemical distribution laws of the total uranium as a function of the petrochemical variations are established. A study of the chemical forms of uranium in the rocks has drawn an attention to the qualitative and quantitative importance of the fraction of this uranium soluble in dilute acids. The laws of distribution of the insoluble uranium, which represents essentially the uranium fixed in crystalline structures (zircon, allanite, etc.,), and the interest presented by the soluble uranium are discussed. This, although more complex in character, presents a geochemical unity in postmagmatic phenomena which makes it possible to find a genetic connection between the uraniferous deposits and the intrusive massifs. Finally, a plan of the geochemical cycle of uranium is given in which is hoped to provide some more accurate data on the igneous phase. (Diss. Abstr. Int., B)

**27919** (GJO-912-21) SUBSURFACE STRATIGRAPHY AND URANIUM-VANADIUM FAVORABILITY OF THE MORRISON FORMATION, SAGE PLAIN AREA, SOUTHEASTERN UTAH AND SOUTHWESTERN COLORADO. Girdley, W. A.; Flook, J. E.; Harris, R. E. (Pitkin (Lucius), Inc., Grand Junction, Colo. (USA)). Aug 1975. Contract AT(05-1)-912. 148p. Dep. NTIS $10.50.

The four members of the Morrison Formation that are recognizable in the area studied are, in ascending order, the Salt Wash, Recapture, Westwater Canyon, and Brushy Basin. The Salt Wash member has the highest uranium favorability of all the Morrison strata in the area studied. An especially favorable area, in which the Salt Wash interval is thick and contains several thick sandstones, is situated on either side of the Utah-Colorado state line between Monticello, Utah, and Dove Creek, Colorado. The upper Morrison strata (Westwater Canyon and Brushy Basin members) have low uranium favorability. The Westwater Canyon member contains adequate sandstones but lacks known uranium deposits in the project area. The Brushy Basin member, although rated as having low potential, nevertheless does possess some attributes that make it worthy of further attention. The Recapture member does not contain sufficient well-developed sandstones or uranium deposits to merit its being classed as favorable for potential uranium-vanadium resources. (LK)

**27920** (GJO-1646) FEASIBILITY STUDY FOR AN AIRBORNE HIGH-SENSITIVITY GAMMA-RAY SURVEY OF ALASKA, Phase II (Final) Report: 1976-1979 Program. (Texas Instruments, Inc., Dallas (USA)). 1975. Contract AT(05-1)-1646. 384p. Dep. NTIS $22.25.

This study constitutes a determination of the extent to which it is feasible to use airborne, high-sensitivity gamma spectrometer systems for uranium reconnaissance in the State of Alaska, and specification of a preliminary plan for surveying the entire state of the 1975–1979 time frame. Phase I included the design of a program to survey the highest priority areas in 1975 using available aircraft and spectrometer equipment. This has now resulted in a contract for 10,305 flight line miles to cover about 11 of the 1:250,000 scale quadrangles using a DC-3 aircraft with an average 6.25 x 25 mile grid of flight line. Phase II includes the design of alternative programs to cover the remaining 128 quadrangles using either a DC-3 and a Bell 205A helicopter or a Helio Stallion STOL aircraft and a Bell 205A helicopter during 1976-1979. The 1976-1979 time frame allows some time for possible new system developments in both airborne gamma-ray spectrometers and in ancillary equipment, and these are outlined. (auth)

**27921** (NP-20534) CHEMICAL ORE GENESIS MODELS FOR THE PRECIPITATION OF CARNOTITE IN CALCRETE. Mann, A. W. (Commonwealth Scientific and Industrial Research Organization, Port Melbourne (Australia). Div. of Mineral Chemistry). Oct 1974. 20p. Dep. NTIS (US Sales Only) $4.00.

An investigation was carried out on the chemical mechanism responsible for the precipitation of carnotite in calcrete. The correct interpretation of uranium and vanadium movement in groundwater may only be possible after a careful and detailed evaluation of the occurrence (or non-occurrence) of many other uranium-vanadium complex salts, particularly those of calcium. It is concluded that a redox controlled mechanism for the precipitation of carnotite from groundwaters seems most likely. (AT)

**27922** URANIUM ORE DEPOSITS IN THE USA. Siegers, A. (Urangesellschaft m. b. H. und Co. K. G., Denver, Colo. (USA)). Erzmetall; 27: No. 6, 274-280(Jun 1974). (In German).

After a brief retrospect on the uranium production in the USA back to 1948 the characteristic features of the producing regions are given. In particular, the specific characteristics of the most important ore deposits, Colorado-Plateau, Wyoming, New Mexico, and Texas, are described with respect to their geology. Future possibilities of exploration activities in the USA are evaluated. (GE)

**27923** STRONG DEMAND FOR NATURAL URANIUM. Demand Likely to Increase by 1,000 t p.a. As From 1980 Onwards. Kalinowski, P. VDI (Ver. Dtsch. Ing.) Nachr.; 29: No. 2, 5(Jan 1975). (In German).

From symposium on natural uranium supply; Mainz, F. R. Germany (18 Nov 1974). 1 fig.

The Deutsches Atomforum and the task group "fuel elements" of the Kerntechnische Gesellschaft had organized an international two-day symposium in Mainz on natural uranium supply which was attended by 250 experts from 20 countries. The four main themes were: demand for natural uranium, uranium deposits and uranium production, attitude of the uranium producing countries, and energy policy of the industrial nations. (GE)

## Radioactivity Monitoring and Transport

*Refer also to abstracts 27956, 27958, 27974, and 30374.*

**27924** (BNWL-SA-4478) $^{129}I$, $^{60}Co$, AND $^{106}Ru$ MEASUREMENTS ON WATER SAMPLES FROM THE HANFORD PROJECT ENVIRONS. Brauer, F. P.; Rieck, H. G. Jr. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1973. Contract AT(45-1)-1830. 41p. (CONF-730111-2). Dep. NTIS $5.25.

From American Chemical Society winter meeting; Newport Beach, California, USA (28 Jan 1973).

Groundwater flow and contamination patterns beneath the Hanford project reservation have been studied since the early days of the project. The measurement of radioactive materials at concentrations much below those required for radiation protection are useful for tracing groundwater movement and detection of potential contamination problems before they are apt to occur. Groundwater samples from a number of wells on or near the Hanford reservation have been analyzed for $^{129}I$ by neutron activation analysis and for gamma radioactivity by low-level coincidence gamma-ray spectrometry. The major radionuclides in addition to natural radioactivity detected in the underground waters by gamma-ray spectrometry were $^{106}Ru$ and $^{60}Co$. Local river and rain water samples were also analyzed for $^{129}I$ and long-lived radionuclides. Special sample collection methods were developed to prevent contamination of the water samples during collection. Anions travel farther than cations in underground water systems since soils are primarily cation exchangers and retain the cations. Anion exchange techniques were used in the field and the laboratory to recover the desired radionuclides. Sample sizes ranged up to several thousand liters. This paper discusses the sample collection methods, analysis methods, and results obtained. The methods used were found to provide high sensitivity for groundwater studies. (auth)

**27925** (FOA-C-40005-A3) TRANSFER OF SIMULATED FALLOUT PARTICLES FROM PASTURE TO GRAZING DAIRY CATTLE. Greitz, U.; Ekman, L.; Eriksson, A. (Foersvarets Forskningsanstalt, Stockholm (Sweden)). Oct 1974. 31p. Dep. NTIS (US Sales Only) $4.75.

The transfer of simulated fallout particles from pasture to cows was studied in field experiments. Silica sand particles with a diameter of about 1 mu m and 40 to 63 and 100 to 200 mu m were labelled with $^{140}La$ or $^{141}Ce$. The particles were wet and dry deposited. The 1 mu m particles simulated world wide fallout, the other particles close-in fallout. Two groups of five cows grazed during two periods of seven hours on the same contaminated pen of 400 $m^2$. It was estimated that pens of this size should be completely grazed during each experiment. Quantitative feces collection and radioactivity measurements of feces occurred during 5 days after the end of each grazing. It was found that dry particle retention on edible grass was positively correlated to the air humidity measured at time of particle deposition on the field. Attempts were made to estimate the particle intake of the cows from measurements of grass samples. It was found that the actual intake of the cows was poorly related to the grass measurements. (auth)

**27926** (JPRS-65592) SCIENTIFIC AFFAIRS NO. 475. 3 Sep 1975. Translations on Eastern Europe. 31p. Dep. NTIS $4.75.

This report contains articles concerning the development of and progress in the various theoretical and applied scientific disciplines and technical fields; and the administration, structure, personnel, and research plans of leading East European scientific organizations and institutions, particularly the academies of sciences in Bulgaria, Hungary, and Romania. One article discusses the relationship of atmospheric precipitation in Hungary to the contamination of animal feed and milk by fallout $^{90}Sr$ and $^{90}Y$. (CH)

**27927** (NTIS/PS-75/429) RADIOACTIVITY FROM NUCLEAR POWER PLANTS. A Bibliography with Abstracts. Period Covered: 1964-March 1975. Crockett, P. W. (National Technical Information Service, Springfield, Va. (USA)). Mar 1975. 277p. NTIS $25.00.

The selected references cover the following topics: radioactive waste management and regulations; radiation monitoring; site selection; bioenvironmental effects; radiation hazards and population dosage. (Contains 227 abstracts). (auth)

**27928** (ORO-2412-64) CESIUM-137 DYNAMICS WITHIN A REACTOR EFFLUENT STREAM IN SOUTH CAROLINA. Shure, D. J.; Gottschalk, M. R. (Emory Univ., Atlanta, Ga. (USA). Dept. of Biology). 1975. 27p. (CONF-750503-27). Dep. NTIS $4.50.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

Cesium-137 dynamics were studied in a blackwater creek which had received production reactor effluents from the Savannah River Plant in South Carolina. Most $^{137}Cs$ in the water column is dissolved or in colloidal form and is believed to originate primarily through outflow from an upstream contaminated reservoir. All ecosystem components in the stream have high $^{137}Cs$ concentration factors. Radiocesium concentrations are highest in filamentous algae (332 pCi/g-dry) and suspended particulate matter (100 to 200 pCi/g). Other food chain bases had much lower $^{137}Cs$ levels. Most consumer populations averaged 10 to 50 pCi/g. Radiocesium concentrations decreased in transfers between food chain bases and primary consumers or filter feeders. Omnivores and small predators have similar $^{137}Cs$ concentrations with bioaccumulation occurring by top-carnivores. Radiocesium levels are around 100 pCi/g in largemouth bass and water snakes. Foodweb components in the stream have reached a dynamic equilibrium in $^{137}Cs$ concentrations despite a 10 year absence of reactor operations. Radiocesium levels are apparently being maintained through long-term $^{137}Cs$ cycling in the upstream reservoir and surrounding flood plain forest systems. Rainfall and other physical processes influence the seasonal $^{137}Cs$ fluctuations in stream components. (auth)

**27929** (STI/DOC-10/169) REFERENCE METHODS FOR MARINE RADIOACTIVITY STUDIES II. (International Atomic Energy Agency, Vienna (Austria)). Jul 1975. 244p. IAEA $15.00.

Methods for monitoring certain radionuclides released to the marine environment in effluents from the nuclear industry are discussed. Analytical methods for the identification of radionuclides of the transuranic elements, Ru, Zr, Ag, and I in seawater samples are included. (CH)

**27930** ANNUAL REPORT, 1973. Raleigh, NC; North Carolina State University (1973). 92p.

Programs, personnel, and publications from the university are presented. The marine sciences area expanded to study the effects of construction and operation of a nuclear power plant in the lower Cape Fear river area of the state. Biological communities in the proposed intake and outfall areas are being described and the entire system will be studied before and after plant construction. Primary focus of the project will be the effects of the plant on marine life in the area. Other university programs include study of methane in deep wells, waste water applications to land, waste management, pest management programs, and training in pesticides. (Pollut. Abstr.)

**27931** STUDY OF THE ISOTOPIC EQUILIBRIUM $^{90}Sr/Sr$ IN AN ULTRAEUTROPHIC LAKE OF LATVIA. Leinerte, M. P.; Vadzis, D. R.; Kalninya, Z. K.; Sloka, Ya. Ya. (Inst. of Biology, Riga). Sov. J. Ecol. (Engl. Transl.); 5: No. 5, 462-464(1974).

Translated from Ekologiya; 5: No. 5, 77-79(1974).

Concentrations of stable Sr and $^{90}Sr$ were determined in water, soils, plankton, aquatic plants, and fishes of Lake Engures. From spring to autumn the concentration of $^{90}Sr$ in the water increased by 70%, while the concentration of stable Sr increased by only 25%. There was a more pronounced increase in stable Sr in the plants than in plankton. No changes were observed in the specific activity of Sr in fishes. (HLW)

## Atmosphere

*Refer also to abstracts 27991 and 30374.*

**27932** (COO-3049-6) MANAGEMENT OF GASEOUS RADIOACTIVE WASTES. Technical Progress Report, September 1, 1974-August 31, 1975. First, M. W. (Harvard School of Public Health, Boston, Mass. (USA)). 1975. Contract AT(11-1)-3049. 4p. Dep. NTIS $4.00.

Multi-ply absolute filter units were manufactured and are undergoing tests for penetration, loading, and heat resistance characteristics. All-metal fiber prefilters are under test with salt aerosols to investigate their particle retention characteristics at elevated temperatures and ability to protect downstream absolute filters from fire and smoke damage. (auth)

**27933** (LA-UR-75-1419) DISPOSITION OF TA-33-21, A PLUTONIUM CONTAMINATED EXPERIMENTAL FACILITY. Cox, E. J.; Garde, R.; Valentine, A. M. (Los Alamos Scientific Lab., N. Mex. (USA)). 21 Jul 1975. 44p. Dep. NTIS $5.25.

The report discusses the decontamination, demolition and disposal of a plutonium contaminated experimental physics facility which housed physics experiments with plutonium from 1951 until 1960. The results of preliminary decontamination efforts in 1960 are reported along with health physics, waste management, and environmental aspects of final disposition work accomplished during 1974 and 1975. (auth)

**27934** (NTIS/PS-75/517) PRECIPITATION WASHOUT (A BIBLIOGRAPHY WITH ABSTRACTS). Period Covered: 1964-June 1975. Lehmann, E. J. (National Technical Information Service, Springfield, Va. (USA)). Jun 1975. 121p. NTIS $25.00.

The reports cited in this bibliography cover the removal of

pollutants, radioactive isotopes, and dust by rain and snow. The theory, modeling, sampling, and effects of precipitation washout are presented. (auth)

**27935** (ORNL-5071) EVALUATION OF RADIOLOGICAL EXPOSURE FROM PLOWSHARE APPLICATIONS, 1967-1975. Barton, C. J.; Kaye, S. V. (comps.). (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 33p. Dep. NTIS $4.00.

A review of the highlights and accomplishments of the nine-year program, FY 1967-75, at ORNL on the evaluation of the radiologica exposure from Plowshare applications is presented. Conclusions based on the studies summarized are given. Chronological lists of presentations, reports and open literature publications on the various investigations of the program are appended to the report. (auth)

**27936** ENVIRONMENTAL IMPACT OF $^{129}I$ RELEASED BY A NUCLEAR FUEL-REPROCESSING PLANT. Palms, J. M. (Emory Univ., Atlanta); Veluri, V. R.; Boone, F. W. Nucl. Saf.; 16: No. 5, 593-602(1975).

The environmental impact of $^{129}I$ released by the Allied-General Nuclear Services-Barnwell Nuclear Fuel Plant (BNFP) is assessed. On the basis of present knowledge, it is expected that the predicted releases from the plant will not raise the concentration of $^{129}I$ to levels that would be hazardous to man or the environment. This article summarizes the analyses associated with the release of $^{129}I$ to the environment, including the presently estimated BNFP releases and calculations of resulting dose to man using the state-of-the-art dose models. Thyroid doses are calculated by the specific activity model and the critical pathway model. The degree of conservativeness involved in the specific activity model which makes it unacceptable as a realistic model is discussed, and the critical pathway model is briefly assessed. Thyroid doses for adults and infants due to inhalation and ingestion are presented. For an air concentration of $3.6 \times 10^{-5}$ pCi/m$^3$ of $^{129}I$, resulting from a release at the rate of $1.5 \times 10^{-9}$ Ci/sec, the infant and the adult thyroid doses due to ingestion via milk are calculated by the critical pathway model to be 0.24 and 0.12 mrem/year, respectively. The adult thyroid dose due to ingestion of leafy vegetables is found to be 0.04 mrem/year. The inhalation and whole-body doses are orders of magnitude smaller. (auth)

**27937** EFFECT OF ATMOSPHERIC PRESSURE VARIATIONS ON THE RADON-222 CONCENTRATION IN UNVENTILATED ROOMS. Jonassen, N. (Danmarks Tekniske Hoejskole, Lynby). Health Phys.; 29: No. 1, 216-220(Jul 1975).

A series of experiments to measure the short-lived airborne daughters of $^{222}Ra$ in an unventilated basement room are described. Variations were found in the $^{222}Ra$ activity and the daughter concentrations with pressure. This variation is due to the change in exhalation rate of $^{222}Ra$ from the walls with changing atmospheric pressure. The mechanism is discussed. If the exhalation rates of different materials, for instance building materials, are to be compared, the determinations of the coefficients should preferably be done at constant pressure. (UK)

**27938** DIFFUSION SAMPLER USEFUL FOR MEASURING DIFFUSION COEFFICIENTS AND UNATTACHED FRACTION OF RADON AND THORON DECAY PRODUCTS. Kotrappa, P.; Bhanti, D. P.; Dhandayutham, R. (Bhabha Atomic Research Centre, Bombay). Health Phys.; 29: No. 1, 155-162(Jul 1975).

A diffusion sampler is designed based on Mercer's theory of diffusional deposition from a fluid flowing radially between two coaxial, parallel circular plates. Experimental measurement of the diffusion coefficient for Th-B atoms indicated that the distortion of the flow patterns at the entrance and at the vicinity of the exit does not have a significant effect. It is, therefore, useful for measuring the diffusion coefficients. The diffusion coefficient for the Th-B atoms measured in condensation nuclei free atmosphere comes out to be 0.055 cm$^2$/sec. This instrument when used at a sampling rate of 1.41 l/min is found to collect 65% of the unattached decay products of thoron on the collection plates suitable for direct analysis. It is, therefore, useful for measuring the unattached fractions of radon and thoron decay products in mines and mills, a measurement of significance in assessing the hazards of radon and thoron. Such measurements done in thorium processing areas indicated an unattached fraction as defined by ICRP to be (0.027 ± 0.021)% compared to 0.05% assumed by ICRP in arriving at the MPCa for thoron. Data reported also include the measured concentrations of thoron (Tn) and the ratios, Tn:Th-B:Th-C. (auth)

**27939** BUNDESTAG DEBATE ON ENVIRONMENTAL RADIOACTIVITY AND PROTECTION FROM THE DANGER OF RADIOACTIVE RADIATION. Baum, G. R. (Bundesministerium des Innern, Bonn (F. R. Germany)). Umwelt (Inf. Bundesminist. Innern); No. 40, 4-5(Apr 1975). (In German).

A brief review of the tasks and duties of the Federal Republic for the protection of the population from the danger of ionizing radiation and for the information given to the public, also within the framework of the energy program, is given. (GE)

## Soil

*Refer also to abstracts 28719–28727 and 28731.*

**27940** RADIOACTIVITY LEVELS IN ENIWETOK SOIL. Gudiksen, P. H.; Lynch, O. D. T. Jr. (Univ. of California, Livermore). Health Phys.; 29: No. 1, 17-25(Jul 1975).

A radiological survey was performed to define the distributions of radioactivity within the soil on the islands in the Eniwetok Atoll, a former U.S. nuclear weapons test site in the Pacific. Soil samples were collected on each of the 40 islands within the atoll. Special emphasis, in terms of increased sample collections, was given to islands expected to have been the most affected by the testing program as well as those considered to be the most likely sites for future habitation. The predominant radionuclides observed in the samples were $^{90}Sr$, $^{137}Cs$, $^{239}Pu$, and $^{60}Co$. In general, the activities appeared to approximate log-normal distributions. Geometric mean values were determined for each area exhibiting significantly different radiological characteristics. The distribution of activity with soil depth shows a wide range of variations. The island of Yvonne is the most contaminated land area within the atoll. Particles containing as much as several milligrams of plutonium are randomly scattered on or near the surface over most of the northern part of the island. In addition, the northern tip of the island includes the highest external gamma levels (500 to 750 mu R/hr) due to soil radioactivity found on the atoll. (auth)

## Water

**27941** POLONIUM-210: ITS VERTICAL OCEANIC TRANSPORT BY ZOOPLANKTON METABOLIC ACTIVITY. Cherry, R. D.; Fowler, S. W.; Beasley, T. M.; Heyraud, M. (International Atomic Energy Agency, Monaco-Ville, Monaco). Mar. Chem.; 3: No. 2, 105-110(Jun 1975).

An earlier work based on atmospheric input of $^{210}Po$ to oceanic surface waters in situ production from its radioactive precursors and its measured equilibrium concentration has shown that $^{210}Po$ is removed from the upper mixed layer at a rapid rate expressible by a turnover (or mean residence) time of 0.6 years. Since $^{210}Po$ is known to be highly concentrated in numerous marine species, a method was devised to assess the importance of marine zooplankton in removing this radio-nuclide from the surface waters. Measurements of $^{210}Po$ losses from living zooplankton lead to a rapid turnover time of the order of 0.9 years due to zooplankton metabolic activity alone. It is shown experimentally that fecal pellet deposition constitutes a major mechanism in transporting the radionuclide from surface to deeper waters. (auth)

## Ecosystems and Food Cycles

*Refer also to abstract 27957.*

**27942** (ORNL-TM-5056) OAK RIDGE, TENNESSEE, FLORA: HABITATS OF THE VASCULAR PLANTS, REVISED INVENTORY. Mann, L. K.; Bierner, M. W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 143p. Dep. NTIS $5.45.

Plant habitats in the Oak Ridge area range from open streams and swamps to dry wooded ridgetops. A categorization of vascular plant species by habitat is presented to simplify the use of the flora listing. This type of listing is also useful in acquiring descriptive material for environmental reports of impact assessment within the immediate vicinity and is the basis of the habitat discussions in the Oak Ridge environmental analysis of the US ERDA operations in Oak Ridge, Tennessee. (auth)

**27943** RADIOACTIVITY IN DIET. Bruce, R. S. (Agricultural Research Council, Wantage, Eng.). Toxicology; 4: No. 3, 392-393(Jul 1975).

From food safety symposium; London, Eng. (21 Nov 1974).

**27944** URANIUM AND RADIOACTIVITY. Eschnauer, H. pp 164-171 Spurenelemente in Wein und Anderen Getraenken. Weinheim, Ger.; Verlag Chemie (1974). (In German)

6 tabs.; 31 refs. Separate print.

Results of investigations on uranium content and the proportion of induced and natural radioactivity in wines of different vines and regions are given. The ecological chain of ground, vine, grape, grape-juice, and wine is described, and it is shown that $^{14}C$

and T measurements can be used to determine the age of wines with the aim of detecting adulterated vintages and blends of different years. The $^{14}C$ and T content also indicates a direct connection with nuclear explosions. (GE)

**27945** FALLOUT PLUTONIUM IN SWEDISH REINDEER LICHENS. Holm, E.; Persson, R. B. R. (Univ. of Lund, Sweden). Health Phys.; 29: No. 1, 43-51(Jul 1975).

The fall-out of $^{239}Pu$ and $^{238}Pu$ has been investigated by studying samples of various species of lichen collected during 1947 to 1961 at different places in Scandinavia and between 1961 and 1972 (Cladonia alpestris) at Lake Rogen in Sweden, which lies at 62.3°N, 12.4°E. The maximal $^{239}Pu$ level in the lichen carpet, which occurred in 1963, was about 300 pCi per kg dry weight, and it decreased to about 200 pCi per kg dry weight in 1970. The mean residence time for $^{239}Pu$ in the whole lichen carpet was estimated to 6.1 ± 0.5 yr and in the 3-cm top layer to 4.3 ± 0.5 yr. The $^{238}Pu$ concentration showed a maximum value during 1963 corresponding to about 12 pCi per kg dry weight. This concentration decreased to about 7 pCi per kg dry weight in 1967. During 1966 to 1970 the $^{238}Pu$ concentration increased and resulted in an increase of the $^{238}Pu/^{239}Pu$ activity ratio from 0.026 ± 0.003 to 0.046 ± 0.003. The total area-deposition of $^{238}Pu$ at the sampling place (62.3°N, 12.4°E) was estimated to 1.0 ± 0.1 mCi $km^{-2}$ in 1972. The corresponding value for $^{238}Pu$ was 0.036 ± 0.004 mCi $km^{-2}$ of which 0.013 ± 0.002 mCi $km^{-2}$ was due to SNAP-9A. The vertical distribution of the plutonium isotopes in the lichen carpet has also been studied. Results of the $^{239}Pu$-activity concentrations in reindeer liver and bone indicate a fractional gastrointestinal absorption of plutonium in reindeer in the order of $(3 \pm 2) \cdot 10^{-5}$. (auth)

**27946** IDENTIFICATION OF AN HOMOGENEOUS CRITICAL GROUP USING STATISTICAL EXTREME VALUE THEORY: APPLICATION TO LAVERBREAD CONSUMERS AND THE WINDSCALE LIQUID EFFLUENT DISCHARGES. Beach, S. A. (National Radiological Protection Board, Harwell, Eng.). Health Phys.; 29: No. 1, 171-179(Jul 1975).

The International Commission on Radiological Protection states that a critical group should be representative of those individuals in the population expected to receive the highest dose. The appropriate dose limit should then be applied to the mean dose of this group. The edible seaweed Porphyra (laverbread) has been identified as the link in the critical exposure pathway limiting discharges of controlled low-level radioactive liquid waste from Windscale. The frequency distributions of the largest values of samples of 10, 20, 30, 40, and 50 male and female, child and adult consumers of laverbread are determined from the parent distributions by Monte Carlo sampling methods. From these results the extreme-value distribution of adult males of samples of 30 is taken to be a good estimate of the critical group, from which the median consumption rate of laverbread consumed per day is 55 g. The annual collective organ dose delivered to the lower large intestine of the total leverbread consumer group is estimated to be 266 man-rem. (auth)

**27947** PLUTONIUM ALPHA ACTIVITY OF FOODSTUFFS. Frindik, O.; Diehl, J. F. (Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe (F. R. Germany). Inst. fuer Strahlentechnologie). Dtsch. Lebensm.-Rundsch.; 71: No. 3, 100-104(Mar 1975). (In German).

4 tabs.; 18 refs. Special print.

The plutonium contents of some foodstuffs and of total daily diets (including beverages) of adults were determined. For this purpose all samples were dry-ashed at 400°C, mixed with $^{236}Pu$ as an internal standard, and the Pu-isotopes were estimated by means of alphaspectrometry. Only in one of the 28 daily rations was a $^{239}Pu/^{240}Pu$-value and in another one a $^{238}Pu$-value found that was above the detection limit of 6 fCi. Of the individual foodstuffs of animal origin only one of four beef liver samples had a plutonium content that can be considered as statistically significant. Some unpeeled foodstuffs of vegetable origin (apples, pears, wheat) also showed a measurable plutonium content. In all instances the measured plutonium activity was within the range that was to be expected due to the present contamination of the biosphere by nuclear tests ($^{239}Pu/^{240}Pu$) and by satellite batteries ($^{238}Pu$). (GE)

**27948** TRANSPORT OF RADIOACTIVE MATERIALS BY JACKRABBITS ON THE HANFORD RESERVATION. O'Farrell, T. P.; Gilbert, R. O. (Battelle Pacific Northwest Labs., Richland, WA). Health Phys.; 29: No. 1, 9-15(Jul 1975).

A survey was conducted near waste disposal trenches (B-C Cribs), Hanford Reservation, south-central Washington, to learn the extent to which jackrabbits (Lepus californicus) and their predators had dispersed radioactive salts, and to relate these data with parameters, such as topography, wind direction, vegetation types, and animal behavior, that might help explain the pattern of dispersal. Animals had access to the radionuclides for an unknown duration between 1958 and 1964. Radioactive feces, urine, soil, and vegetation were distributed in all directions from the cribs, but the area to the south and southwest was more densely and uniformly contaminated. Most feces with a count rate greater than 20,000 counts/min was found within 400 m of the cribs, but jackrabbit pellets with count rates in excess of 100,000 counts/min were found up to 1.6 km from the cribs. Surveys were conducted over 3000 ha and up to 20 km from the cribs to determine whether predators of jackrabbits were also involved in spreading radioactivity. The results show how abundant native animals can effectively transport radioactive wastes. The potential for similar occurrences on nuclear installations should be evaluated so that appropriate measures can be taken to minimize the spread of contamination. (auth)

## Radiometric Techniques

*Refer also to abstract 27957.*

**27949** (ORNL-5055, pp 18-38) ENVIRONS MONITORING. Aug 1975.

In applied health physics and safety annual report for 1974. Progress Report, 1974. (Oak Ridge National Lab., Tenn. (USA)).

There were no releases of gaseous waste from ORNL which were of a level that required an incident report to the ERDA. The average concentration of beta radioactivity in the atmosphere at the perimeter of the ERDA-controlled area was less than one percent of the value applicable to releases to uncontrolled areas. There were no releases of liquid waste from the Laboratory which were of a level that required an incident report to the ERDA. The quantity of radionuclides of primary concern in the Clinch River averaged less than 0.4 percent of the MPC/sub w/. The average background level at the PAM and RAM stations during 1974 was 7.5 mu R/hr, or 0.3 mu R/hr less than the average for 1973. Nine soil samples were collected and analyzed for plutonium and uranium. Plutonium content ranged from $0.9 \times 10^{-8}$ mu Ci/g to $3.4 \times 10^{-8}$ mu Ci/g, and the uranium content ranged from $43 \times 10^{-8}$ mu Ci/g to $117 \times 10^{-8}$ mu Ci/g. (auth)

**27950** (ORNL-5055, pp 39-47) RADIATION AND SAFETY SURVEYS. Aug 1975.

In applied health physics and safety annual report for 1974. Progress Report, 1974. (Oak Ridge National Lab., Tenn. (USA)).

During 1974, the radiation and safety surveys personnel of ORNL continued to assist the operating groups in keeping the contamination, air concentration, and personnel exposure levels below the established maximum permissible levels. They assisted in reducing or eliminating a number of problems associated with radiation protection at the Laboratory. Several man-months were devoted to off-area surveys. The major portion of this time was in assisting in decontamination efforts at the American Nuclear Corporation. Ten unusual occurrences involving radioactive materials were recorded during 1974. The number reported for 1973 was also 10, and the average number for the past five years (1970-1974) was 10.0. Of the 392,100 articles of wearing apparel monitored during 1974, about 13 percent were found contaminated. (auth)

**27951** (RT/GEO-(75)2) PRELIMINARY RESEARCH ON THE DISPLACEMENTS OF THE SAND ON THE SEA BOTTOM. Amadesi, P.; Ciancabilla, F.; Cucchi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Feb 1975. 23p. (In Italian). Dep. NTIS (US Sales Only) $4.25.

The position of the so-called neutral line of the sea-bottom at Porto S. Giorgio on the Adriatic coast (Italy) is determined. Such a line is characterized by the fact that materials dumped on the sea-bottom along it are not displaced by water movements. Its determination is of paramount importance for building jetties with monolithic foundation, perpendicular to the coast. Indeed, if the foundation of the head of the jetty is less deep than the neutral line, the harbor is progressively silted up. The method employed is based on the neutron activation analysis. A certain amount of manganese-containing ore was dumped on some selected points, and after some time samples of the bottom sands were collected around the dumping areas. These samples were dried, ground, and irradiated in a nuclear reactor. Their induced reactivity was then measured. On the basis of such measurements the manganese isoconcentration lines were plotted and have enabled the determination of the position of the neutral line. (auth)

**27952** NUCLEAR PHYSICS AS A DEVICE IN ARCHAEOLOGY. Koenig, V. (Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. fuer Kernphysik). Phys. Bl.; 31: No. 3, 104-114(Mar 1975). (In German).

A review of the applications of nuclear physics in archaeology is given. It deals with the age dating by the radio-carbon-method,

the determination of the origin of potter's ware by neutron activation methods and X-ray spectroscopy and the research of internal structures. (GE)

**27953** EVIDENCE FOR INITIAL $^{36}Ar$ IN VOLCANIC ROCKS, AND SOME IMPLICATIONS. Mellor, D. W.; Mussett, A. E. (Liverpool Univ. (UK)). Earth Planet. Sci. Lett.; 26: No. 3, 312-318(Jul 1975).

Evidence is presented that volcanic rocks may contain initial argon, and some of the implications of the results are presented. The incorporation of initial argon with a composition different to that of air at the time of crystallization may be an important cause of scatter of K–Ar dates in areas such as the British Tertiary igneous province, but in favorable circumstances the correct age may be recovered. An age of about 60 Ma is indicated for the lavas of Northern Ireland. (auth)

**27954** $^{40}Ar/^{39}Ar$ STEP HEATING OF THERMALLY OVERPRINTED BIOTITE, HORNBLENDE, AND POTASSIUM FELDSPAR FROM ELDORA, COLORADO. Berger, G. W. (Toronto Univ., Ontario (Canada). Dept. of Physics). Earth Planet. Sci. Lett.; 26: No. 3, 387-408(Jul 1975).

$^{40}Ar/^{39}Ar$ incremental heating experiments were applied to hornblendes, coarse-grained biotites and K-feldspars from 1400 m.y. old rocks near the contact with the ~60 m.y. old Eldora stock in the Front Range of Colorado. The aim was to distinguish, on the basis of argon isotopic data alone, a partially re-set K–Ar date from an undisturbed or a completely overprinted K–Ar date. In the laboratory heating of biotites the radiogenic argon ($^{40}Ar^*$) and potassium-derived $^{39}Ar(^{39}Ar^*)$ were released in two stages: in the range ~600 to 900°C and above ~900°C. The two biotites furthest from the contact and the one adjacent to the contact give well-defined apparent-age plateaus at ~1230 m.y. and 63 m.y. respectively for all argon released above ~600°C. The bulk of the $^{40}Ar^*$ and $^{39}Ar^*$ in the hornblendes was released in the range ~950–1100°C. The hornblende furthest from the contact gives a well-defined plateau at 1400 m.y. for the 98% of the argon that was released above ~950°C. For the feldspars the bulk of the $^{40}Ar^*$ and $^{39}Ar^*$ was released in the laboratory heating between about 900°C and 1200°C, probably reflecting phase changes near these temperatures. The argon released below about 900°C records reasonable maximum dates for the time of the thermal overprinting. (auth)

**27955** Rb–Sr AGE OF THE MASHONALAND DOLERITES OF RHODESIA AND ITS SIGNIFICANCE FOR PALEOMAGNETIC CORRELATION IN SOUTHERN AFRICA. Compston, W.; McElhinny, M. W. (Australian National Univ., Canberra). Precambrian Res.; 2: No. 3, 305-315(Jul 1975).

Palaeomagnetic correlation in southern Africa predicts that the age of the Mashonaland dolerites of Rhodesia is confined within the limits of the age of the Waterberg System of South Africa, viz., between 1,950 m.y. and about 1,750 m.y. Rb–Sr data from the dolerites confirm this prediction. One sample gave a mineral isochron of 1,850 ± 20 m.y., which may be the true age of emplacement and is certainly a reliable minimum estimate for it. Total rock samples from nine dykes define an isochron of age 1,910 ± 280 m.y. and initial $^{87}Sr/^{86}Sr$ of 0.705 ± 0.002. In addition to variation in initial $^{87}Sr/^{86}Sr$ between dykes, there is also variation between minerals within single dykes presumably due to contamination during crystallization and/or deuteric alteration. (NL)

## Site Surveys

*Refer also to abstracts 27916, 28275, and 30334.*

**27956** (MLM-2249) MOUND LABORATORY ENVIRONMENTAL PLUTONIUM STUDY, 1974. Rogers, D. R. (Mound Lab., Miamisburg, Ohio (USA)). 15 Sep 1975. Contract E-33-1-GEN-53. 143p. Dep. NTIS $5.45.

In 1974, Mound Laboratory found that the sediment in certain waterways near the laboratory site appeared to exhibit plutonium-238 concentrations higher than the expected baseline levels. As a result, Mound Laboratory initiated a comprehensive environmental plutonium-238 study to determine the full extent of the contamination, the cause, and mechanisms of the release, and the health and safety impact of these deposits on the public. Over 1750 soil, sediment, biota, water, and air samples were collected in the off-site areas and analyzed for plutonium-238. From these data, it was determined that about 5.2 curies of plutonium-238 are deposited in these waterways, mostly buried under up to 3 ft of sediment. An intensive investigation identified the cause of the plutonium-238 deposits and the mechanisms of the release, transport and deposition into these off-site waterways. Experimental laboratory studies and field observations were used to verify these mechanisms. In January, 1969, an underground pipeline carrying plutonium-238 waste solution ruptured. Acidic waste solution containing plutonium-238 was released to the soil adjacent to the pipe. The plutonium was quickly and strongly sorbed by the soil where it was immobilized. During the excavation and repair operations, when the contaminated soil was most susceptible to erosion, the weather warmed, and intense rain was experienced for two days. This heavy rain eroded the exposed surface of the contaminated soil causing the soil particles to be carried off-site. These erosion products, suspended in the moving water, settled according to normal sedimentation processes in the waterways adjacent to Mound Laboratory. Water sampling performed during this occurrence failed to detect this movement because the plutonium was in the sediment. The health and safety aspects of the plutonium-238 sediment deposits were evaluated under the prevailing conditions and under credible worst-case future conditions. (auth)

**27957** (NERC-LV-539-20) 1971 ANIMAL INVESTIGATION PROGRAM. Annual Report. Smith, D. D.; Giles, K. R. (National Environmental Research Center, Las Vegas, Nev. (USA)). Jul 1975. Contract AT(26-1)-539. 39p. Dep. NTIS $5.45.

Data are presented that were obtained from the radioanalysis of tissues collected from cattle, deer, desert bighorn sheep, and other wildlife that reside on or near the Nevada Test Site. Cesium-137 and $^{106}Ru$ were the only gamma-emitting radionuclides detected in the soft tissues of range cattle. Ruthenium-106 was detected only in the lungs of animals sampled in May. Strontium-90 levels in the cattle femurs ranged from 2 to 37 pCi/g of ash. The latter value was found in the bones of a 14-year-old cow that had lived on the Nevada Test Site her entire life. The bones of the same animal also had the highest level of $^{239}Pu$ (46 pCi/g of ash) that was reported. Analysis of her 8-month-old fetus revealed the presence of detectable levels of $^{239}Pu$ which indicates placental transfer of this radionuclide. The average $^{90}Sr$ levels in the bones from deer and desert bighorn sheep were 3.2 and 4.7 pCi/g of ash, respectively. Elevated levels of $^{106}Ru$ and $^{3}H$ were found in the tissues of two mule deer collected near the drainage ponds that collect runoff waters from mines used for nuclear testing activities. Other animals sampled included Golden eagles, feral horses, coyotes, and chukar. The $^{137}Cs$ levels in an eagle collected during 1964 varied only slightly from one collected during 1971. No gross or microscopic lesions were detected that could be attributable to the effects of ionizing radiation. (auth)

**27958** (ORO-4851-81) EFFECT OF TEMPERATURE AND HYDROXY-Al INTERLAYERS ON Cs SELECTIVITY AND FIXATION IN RIVER SUSPENSIONS AND SOILS. Progress Report, 1974–1975. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). 1975. 86p. Dep. NTIS $7.50.

Streambed sediments were collected from selected sites at the Savannah River Plant, namely, Upper Three Run, Lower Three Run, Steel Creek, Four Mile Creek, Pen Branch, Par Pond (Thermally Affected), Par Pond (Thermally Not Affected), and Savannah River sediments. Particle size analysis showed that Savannah River sediment had 36.92 percent sand, 37.74 percent silt, and 25.34 percent clay. The other sediments had 75.75 to 99.43 percent sand, 0.24 to 6.16 percent silt, and 0.26 to 13.14 percent clay. Free iron oxide was almost absent in all sediments except that in Savannah River where it constituted 2.14 percent. Organic matter content varied from 0.06 in Steel Creek to 5.69 percent in Pen Branch. Extensive mineralogical analysis showed that two major soil clays existed in the sediments namely kaolinite and integrade. The effect of hydroxyl-Al interlayers on the selectivity of Cs–Na ion exchange thermodynamics in the sediments was studied. (CH)

**27959** (PRNC-184) HYDROGRAPHIC DATA REPORT, WEST COAST OF PUERTO RICO, 1973–1974. Wood, E. D.; Asencio, R. (Puerto Rico Nuclear Center, Mayaguez). 1 May 1975. 157p. Dep. NTIS $11.00.

The hydrographic data included in this report were collected as part of a site selection survey to provide basic oceanographic data to assist the Puerto Rico Water Resources Authority in determining the best locations for additional electrical power generating facilities on the island, both nuclear and fossil fuel. Classical oceanographic methods were used in sampling and analyzing sea water at depths from 10 to 300 meters. This report includes data from two sites: the Punta Higuero site, PHI, is the site of the former "BONUS" nuclear power plant and the Cabo Rojo Platform, CRP, is a possible site for offshore power generating plants. The two west coast sites are centered about 30 kilometers apart. (CH)

## Thermal Effluents

**27960** (NTIS/PS--75/218) THERMAL POLLUTION. Part 1. Control Techniques and General Studies. A Bibliography

With Abstracts. Period Covered by Report: 1964--December 1974. Lehmann, E. J. (National Technical Information Service, Springfield, Va. (USA)). Feb 1975. 139p. NTIS $25.00.

Cited are 85 reports concerned with control techniques for heated effluents from power plants and industrial plants. Also included are studies on general thermal pollution problems and their abatement. (auth)

**27961** (NTIS/PS-75/219) THERMAL POLLUTION. Part 2. Biological Effects. A Bibliography With Abstracts. Period Covered by Report: 1964-December 1974. (National Technical Information Service, Springfield, Va. (USA)). 1975. 225p. NTIS $25.00.

Presented are 171 abstracts covering the effects of heated effluents on fish, microorganisms, and plants in both fresh and salt water. This includes the effects on growth, ecology, metabolism, heat tolerance, and productivity. (auth)

**27962** (NTIS/PS-75/220) THERMAL POLLUTION. Part 3. Hydrology and Hydrodynamics. A Bibliography with Abstracts. Period Covered by Report: 1964--December 1974. Lehmann, E. J. (National Technical Information Service, Springfield, Va. (USA)). Feb 1975. 129p. NTIS $25.00.

All aspects of the hydrology and hydrodynamics of heated effluents are covered in 124 citations. This includes mixing, diffusion, modeling, heat transfer, and flow. (auth)

**27963** (NTIS/PS-75/549) COOLING TOWERS. A Bibliography With Abstracts. Period Covered: 1964--June 1975. Hundemann, A. S. (National Technical Information Service, Springfield, Va. (USA)). Jul 1975. 169p. NTIS $25.00.

Abstracts dealing with design and environmental impacts of wet and dry cooling towers are presented. Cooling tower drift instrumentation and thermal and chemical pollution control systems are covered. Most abstracts pertain to cooling towers used in nuclear power plants; a few abstracts pertain to cooling towers used in wastewater treatment. (Contains 123 abstracts). (auth)

**27964** (ORNL-EIS-75-28) THERMAL EFFECTS ON AQUATIC ORGANISMS: ANNOTATED BIBLIOGRAPHY OF THE 1974 LITERATURE. Coutant, C. C.; Talmage, S. S.; Carrier, R. F.; Collier, B. N. (comps.). (Oak Ridge National Lab., Tenn. (USA)). Jun 1975. Contract W-7405-eng-26. 168p. Dep. NTIS $11.50.

The annotated bibliography covers the 1974 literature concerning thermal effects on aquatic organisms. Emphasis is placed on the effects of the release of thermal effluents on aquatic ecosystems. Indexes are provided for: author, keywords, subject category, geographic location, taxon, and title (alphabetical listing of keyword-in-context of the nontrivial words in the title). (CH)

**27965** (SRO-757-3) EFFECTS OF HEATED EFFLUENTS ON THE REPRODUCTION OF SELECTED SPECIES OF THE CENTRARCHID FAMILY. Progress Report, 26 October 1973--25 October 1974. Clugston, J. P.; Provost, E. E. (Georgia Univ., Athens (USA). School of Forest Resources). 1974. Contract AT(38-1)-757. 10p. Dep. NTIS $4.00.

The number of species found in the cooling reservoirs differed. Fourteen species were collected in Pond C and 27 species in Par Pond. Largemouth bass, bluegill, redbreast sunfish and mosquitofish were the only species found to reproduce within Pond C. Largemouth bass and bluegill made up over 95 percent of the fishes in this reservoir. Water temperatures undoubtedly limit the number of species and population sizes in Pond C. Fishes in Pond C often frequented water of a temperature very near to or even above temperatures reported as lethal. Bluegill were found in water ranging from 35 to 41°C. Largemouth bass were common in water 32-35°C and to 36-37°C on one occasion. In general, the standing crop of the fishes in Par Pond as determined by cove-rotenone samples were similar to nearby reservoirs in South Carolina. The standing crop found in the heated portion of Par Pond did not differ greatly from ambient waters in 1972. The bass population throughout Par Pond is above that found by fishery biologists in other South Carolina reservoirs and unusually large in the mixing area where the heated effluent enters this reservoir. Evidence is presented which suggests the large population of bass results from the fact that this reservoir has never been available to sport fishermen. The relative abundance of species followed the same trend between coves each year. Fish kills were observed as a result of two different circumstances. At times fish were attracted by cool water and subsequently trapped away from refuge areas and killed by rising temperatures in Pond C. One other type kill occurred when blueback herring migrated from water 16°C and swam into water 25°C. Tracking of largemouth bass with temperature-sensing ultrasonic transmitters suggests there is a continuous rotation of bass into and out of the thermal mixing area in Par Pond and that there is not a discrete population that has been self-acclimated to the warmer water and forced to remain in the heated effluent. (HLW)

**27966** (SRO-757-4) EFFECTS OF HEATED EFFLUENTS FROM A NUCLEAR REACTOR ON SPECIES DIVERSITY, ABUNDANCE, REPRODUCTION, AND MOVEMENT OF FISH. Clugston, J. P. (Georgia Univ., Athens (USA)). 1973. Contract AT(35-1)-757. 112p. Dep. NTIS $8.75.

Thesis.

The number of species found in the cooling reservoirs differed. Fourteen species were collected in Pond C and 27 species in Par Pond. Largemouth bass, bluegill, redbreast sunfish and mosquitofish were the only species found to reproduce within Pond C. Largemouth bass and bluegill made up over 95 percent of the fishes in this reservoir. Water temperatures undoubtedly limit the number of species and population sizes in Pond C. Fishes in Pond C often frequented water of a temperature very near to or even above temperatures reported as lethal. Bluegill were found in water ranging from 35 to 41°C. Largemouth bass were common in water 32-35°C and to 36-37°C on one occasion. In general, the standing crop of the fishes in Par Pond as determined by cove-rotenone samples were similar to nearby reservoirs in South Carolina. The standing crop found in the heated portion of Par Pond did not differ greatly from ambient waters in 1972. The bass population throughout Par Pond is above that found by fishery biologists in other South Carolina reservoirs and unusually large in the mixing area where the heated effluent enters this reservoir. Evidence is presented which suggests the large population of bass results from the fact that this reservoir has never been available to sport fishermen. The relative abundance of species followed the same trend between coves each year. Fish kills were observed as a result of two different circumstances. At times fish were attracted by cool water and subsequently trapped away from refuge areas and killed by rising temperatures in Pond C. One other type kill occurred when blueback herring migrated from water 16°C and swam into water 25°C. Tracking of largemouth bass with temperature-sensing ultrasonic transmitters suggests there is a continuous rotation of bass into and out of the thermal mixing area in Par Pond and that there is not a discrete population that has been self-acclimated to the warmer water and forced to remain in the heated effluent. (HLW)

**27967** METHODOLOGY IN SURVEY OF TEMPERATURE DISTRIBUTION IN RIVERS AND RESERVOIRS: RECEIVERS OF HEATED-UP WATER FROM THERMAL POWER PLANTS. Dobrowolski, A. Gospod. Wodna: No. 8-9. 307(1974).

Requirements for temperature survey in receivers of heated-up outlet water from thermal power plants have been presented. Differences between the a/m survey and the usual hydrometric survey have been pointed out. Problems concerning temperature distribution in rivers and reservoirs, relevant survey, and basic element survey are described. Suggestions and recommendations have been drawn up concerning thermal survey of heated-up outlet water in receivers. (Water Resour. Abstr.)

**27968** GENERAL CONCEPTION IN WATER MANAGEMENT AND USE OF WARM WATER FROM POWER PLANTS IN FARMING OVER THE KONIN AREA. Krol, C. Gospod. Wodna: No. 8-9. 294(1974).

The possibility is discussed of having warm water from power plants put to use in fisheries and in arable land irrigation. Retention of outlet water in fish ponds makes it possible to meet the water deficit at the top station of the Slesin Canal, which would have real importance in intensifying farming production while improving the existing cooling circuit. A concept of organizing the valley in hydrotechnical terms with inclusion of the ponds into the Warta and Notec water system is also presented in the paper. (Water Resour. Abstr.)

**27969** EFFECTS AND METHODS OF CONTROL OF THERMAL DISCHARGES. Part I. Report to the Congress in Accordance with Section 104(t) of the Federal Water Pollution Control Act Amendments of 1972. Congressional Committed Print No. 93-14. Washington, DC: Environmental Protection Agency (1973). 570p. GPO $3.70.

This report is in two parts: Part I is review of the effects of thermal discharges on water quality and Part II is a site by site review of information and data available relating cause and effect relationships. This review examines fifty-two sites that correlated thermal plant characteristics and operations with one or more facets of environmental influence. These fifty-two sites represent a cross-section of the thermal discharge situations across the nation and include streams, impoundments, lakes, estuaries, and coastal waters. Few of the studies have taken into account all the factors which separately but concurrently affect the environment and influence biological populations: factors such as turbidity, velocity, nutrients, and pollutants other than heat itself. Insofar as possible, site studies are presented in the same format; however, where data or information were absent there are blanks in the data summaries. Without comparable data and an accounting of all the influencing

factors it was found to be impossible to assign environmental changes (or effects) to specific causes. However, it is indicated that effects at these sites have been detected. (auth)

**27970** EFFECTS AND METHODS OF CONTROL OF THERMAL DISCHARGES. Part II. Report to the Congress in Accordance with Section 104(t) of the Federal Water Pollution Control Act Amendments of 1972. Congressional Committee Print No. 93-14. Washington, DC; Environmental Protection Agency (1973). 570p. GPO $3.70.

The report to Congress contains five individual reports bearing on the problems of the effects and methods of control of thermal discharge. The individual reports are entitled: Impact of Thermal Discharges on Air Quality, Effects of Thermal Discharges on Land Uses, Methods of Control of Thermal Discharges, Temperature Distribution Analysis, and Thermal Aspects of Aquatic Chemistry. The last report is composed of two separate parts. (auth)

**27971** HEAT DISPOSAL IN WATER ENVIRONMENT. Harleman, D. R. F. J. Hydraul. Div., Am. Soc. Civ. Eng.; 101: No. HY9, 1120-1138(Sep 1975).

The need for continuing development of techniques for predicting temperature distributions due to waste heat discharges into lakes, rivers, estuaries, and the oceans is presented. Diffusion of buoyant jets is examined, including heated surface jets and multiple jets issuing from a submerged multiport diffuser. In the near-field analysis of surface jets the important problems are related to the lateral spreading caused by buoyancy. Comparison of theoretical predictions with laboratory and field observations are given. The mechanics of multiport diffusers for heated discharges in shallow receiving waters are explained in contrast to sewage diffusers. The important problem is the degree to which stratification can be maintained in order to minimize local reintrainment and reduction of dilution capacity. Criteria for stable and unstable flow regimes are provided. A mathematical model for temperature distribution, with or without waste heat addition, in unsteady flows under time-varying meteorological conditions is given. (auth)

**27972** TURBULENT JETS WITH REVERSIBLE BUOYANCY. Jain, S. C.; Pena, J. M. J. Hydraul. Div., Am. Soc. Civ. Eng.; 101: No. HY9, 1221-1233(Sep 1975).

The results of the numerical analysis of turbulent warm water jets discharging into quiescent water at freezing temperature are summarized. Due to the peculiar variation of the density of water at low water temperatures, the behavior of a warm water jet is different from that of a buoyant jet in which the density can be assumed to be a linear function of the temperature. The problem is analyzed by employing the integral approach and assuming similarity conditions for velocity and temperature profiles. The nonlinear variation of density with temperature is included in the analysis. Results for the jet trajectory, width, and dilution are presented in graphical form. These solutions can be used to predict the behavior of warm submerged jets discharging into lakes during winter season when the ambient temperature of the lake is near the freezing mark. (auth)

## Chemical Effluents

*Refer also to abstracts 27482, 27540, and 27934.*

**27973** (NOAA-TM-ERL-ARL-51) EFFLUENT DILUTIONS OVER MOUNTAINOUS TERRAIN. Start, G. E; Ricks, N. R.; Dickson, C. R. (National Oceanic and Atmospheric Administration, Idaho Falls, Idaho (USA). Air Resources Lab.). Dec 1974. 166p. Dep. NTIS $11.50.

The second portion of a two-phase study of atmospheric dilutions of airborne effluents, conducted in the vicinity of mountainous terrain near Garfield, Utah, is described. The study was designed to quantify atmospheric dilution in rough mountainous terrain, without the strong channeling influences of a deep canyon. Aerial and ground-level sampling of sulfur hexafluoride gaseous tracer were performed. Tracer was released mainly from the 122-m chimney of an operating smelter. Gas analyses were performed using an electron capture gas chromatograph. Meteorological observations included pibals, radiosondes, surface winds from a network of stations, and trajectories of radar-tracked tetroons. (auth)

**27974** (NTIS/PS-75/462) OCEAN WASTE DISPOSAL. A Bibliography with Abstracts. Search Period Covered 1964–May 1975. (General Electric Co., Cincinnati, Ohio (USA). Aircraft Nuclear Propulsion Dept.). 1975. 214p. NTIS $25.00.

The majority of the cited topics discuss the ocean disposal of sewage, sewage sludge, and dredged material, although reports on the disposal of radioactive wastes, brines, and industrial wastes are also covered. The ecological effects are included, as is research on the pollution of the New York Bight. However, studies on the discharge of heated effluents is excluded. Contains 164 abstracts. (auth)

**27975** (Y-1993) CHROMATE ABATEMENT IN THE Y-12 PLANT'S NEW HOPE POND. DeMonbrum, J. R.; Muenzer, W. A. (Oak Ridge Y-12 Plant, Tenn (USA)). 3 Sep 1975. Contract W-7405-Eng-26. 34p. Dep. NTIS $4.00.

Results are reported from a 15-months field study that utilized four nonchromate-based water-treatment programs in 16 low-temperature (less than 100°F) cooling towers using corrosion and deposition studies, microbiological control, and plant effluent creek analyses as evaluation parameters. The study succeeded in bringing the chromate content of effluent of the New Hope Pond at the Oak Ridge Y-12 Plant to the limits established by the Environmental Protection Agency. (auth)

# INSTRUMENTATION

## Radiation Detection Instruments

*Refer also to abstract 28329.*

**27976** NATURE OF TRAPS IN CaS:Bi:Pd PHOSPHORS. Lawangar, R. D. (Shivaji Univ., Kolhapur, India); Narlikar, A. V. J. Mater. Sci.; 10: No. 7, 1251-1253(Jul 1975).

A report is presented on photo- and thermoluminescence studies carried out on CaS:Bi:Pd phosphors with a view to investigating the physical and chemical nature of traps responsible for the luminescence. Half the amount of the prepared samples was sulfurized in an atmosphere of $H_2S$ at 900°C for 2½ h. Typical decay curves are shown for the sulfurized and unsulfurized samples. Glow curves are shown of a sample before and after sulfurization. Results are discussed. It is suggested that the traps are associated with defects in the host lattice which are likely to be sulfur vacancies. (UK)

### General Detectors and Monitors

*Refer also to abstracts 27548, 28328, 29161, 29162, 30209, 30405, 30407, and 30421.*

**27977** (AECD/EP-28) IMPROVEMENT OF DIRECTIONAL SENSITIVITY OF $BF_3$ LONG COUNTER. Islam, N.; Hussain, D.; Hussain, M.; Shahjahan, M.; Islam, E. (Atomic Energy Centre, Dacca (Bangladesh); Dacca Univ. (Bangladesh)). Jan 1975. 14p. Dep. NTIS (US Sales Only) $4.00.

A $BF_3$ long counter of the Hanson-Mckibben type has been constructed. To make the counter directionally sensitive a simple detachable collimator has been designed. The angular resolution (half-width at half height) of the long counter is 32° and with the collimator in front of the counter, this becomes 7.2°. This increased resolution makes the counter "see" only a limited experimental area thus reducing the background counts from scattered neutrons and also from secondary neutrons produced in different parts of an accelerator specially when a deuteron beam is used. The energy responses of the collimated and uncollimated long counter have been compared and the absolute efficiency of the long counter has been measured. (auth)

**27978** (AEEW-M-1348) RESIDUAL CURRENTS OBTAINED FROM DC (MEAN CURRENT) FISSION CHAMBERS. Goodings, A. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jul 1975. 11p. Dep. NTIS (US Sales Only) $4.00.

The main causes of residual activation currents in dc mean current ionisation chambers are briefly discussed. Theoretical and experimental aspects of fission product and wall activation effects are considered and performance data for a typical chamber derived. The likely ways in which this performance can be changed by modifications to the design are stated. (auth)

**27979** (ANL-CT-73-45824-0005) INITIAL TEST OF REUTER-STOKES MINERAL-INSULATED CABLE, TYPE RSE 2-0041. Hardtke, F. C.; Hirsch, A.; Cassidy, C. (Argonne National Lab., Ill. (USA)). 15 Aug 1973. 81p. AT.

Two of four Reuter-Stokes (R-S) mineral-insulated cables were tested through two heat cycles which reached maximum temperatures of 1200°F and 850°F, respectively. The testing procedure of RDT Standard F 3-39 T was applied, and both cables failed to display satisfactory (according to performance requirements) resistance (R) and breakdown-pulse-noise (BPN) characteristics in the temperature range of 600 to 800°F in the ascent of the first heat cycle. Subsequent testing revealed even poorer performance due possibly to a heating beyond design intent (850°F) in the first heat cycle. Through the use of a desiccant applied to the high-temperature ends of the cables, the R of both cables increased several decades in a few hours at room temperature. One showed a sizeable increase in the BPN threshold voltage from 600 to 1200 volts due to the dehydration caused by the desiccant. (auth)

**27980** (ANL-CT-75-45824-0004) PRELIMINARY TESTING AT ANL OF THE ORNL FC-3 AND THE TCE (BRITISH) DC-14B, S/N 7304-69 FISSION COUNTER-CHAMBERS. Taboas, A. L.; Buck, W. L. (Argonne National Lab., Ill. (USA)). 9 Sep 1975. Contract W-31-109-Eng-38. 50p. AT.

This report documents most of the test data taken on the ORNL FC-3 and the British DC-14B, S/N 7304-69, fission counters during preliminary testing at ANL from September 1974 to March 1975. The data include capacitances, d-c alpha-plus-leakage saturation characteristics, a-c noise-plus-alpha mean-square-voltage characteristics, neutron counting saturation characteristics, collection times, and noise, alpha and neutron integral bias curves at temperatures up to 750°F. In addition, noise, alpha, gamma and gamma-plus-neutron integral bias curves at room temperature are included. The room temperature d-c gamma and neutron sensitivities are also established. The detector-cable assemblies were electrically insulated, electrostatically shielded, and packaged for in-reactor life testing. The performance of both detectors was judged satisfactory, and the detectors and test instruments were shipped in March 1975 to EBR-II for further testing. (auth)

**27981** (DESY-75/16) SCINTILLATION IN GASES COMMONLY USED AS CHERENKOV RADIATORS. Bertolucci, S.; Bradaschia, C.; Giromini, P.; Mancuso, A.; McCorriston, T.; Rippich, C.; Rohde, M.; Vaccaro, S. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Jul 1975. 8p. Dep. NTIS (US Sales Only) $4.00.

Data related to the scintillation of gases, commonly used as radiators in Cherenkov counters, are presented. Up to a factor of three differences in the scintillation yields of these gases are found. (auth)

**27982** (HEDL-SA-799) CRITICAL REQUIREMENTS OF THE SSTR METHOD. Gold, R. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract E(45-1)-2170. 15p. (CONF-750935-9). Dep. NTIS $4.00.

From 1st ASTM-Euratom symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

Discrepancies have been reported in absolute fission rate measurements observed with Solid State Tract Recorders (SSTR) and fission chambers which lie well outside experimental error. As a result of these comparisons, the reliability of the SSTR method has been seriously questioned, and the fission chamber method has been advanced for sole use in absolute fission rate determinations. In view of the absolute accuracy already reported and well documented for the SSTR method, this conclusion is both surprising and unfortunate. Two independent methods are highly desirable. Moreover, these two methods more than compliment one another, since certain in-core experiments may be amenable to either but not both techniques. Consequently, one cannot abandon the SSTR method without sacrificing crucial advantages. A critical reappraisal of certain aspects of the SSTR method is offered in the hope that the source of the current controversy can be uncovered and a long term beneficial agreement between these two methods can therefore be established. (WHK)

**27983** (HEDL-SA-800) MASS AND CHARGE DEPENDENCE OF SSTR ASYMPTOTIC SENSITIVITY. Gold, R. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract E(45-1)-2170. 8p. (CONF-750935-8). Dep. NTIS $4.00.

From 1st ASTM-Euratom symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

Basic investigations of the Solid State Track Recorder (SSTR) method of absolute fission rate measurements have demonstrated that two types of sources are particularly advantageous. If mu denotes the thickness of the SSTR source in g/cm$^2$ units, then these two advantageous conditions can be expressed as: mu much less than R/sub min/, and mu much greater than R/sub max/, where R/sub min/ and R/sub max/ are the respective minimum and maximum range of fission fragments in the source. Sources which satisfy the first condition are said to lie in the region near the origin, where the SSTR efficiency is constant and the sensitivity is linear in mu. Sources which satisfy the second condition are said to be asymptotically thick. In this region, the efficiency varies as $mu^{-1}$ and the sensitivity is constant. It has become customary to refer to this constant sensitivity as the asymptotic sensitivity and denote it by the symbol s/sub infinity/. In applications where asymptotically thick sources are used for absolute fission rate measurements, it is necessary to determine the number of fissionable atoms at the surface that are observed with 100 percent efficiency. The effective mass per unit area from which all fission fragments are observed is S/sub infinity/. An analytical expression for S/sub infinity/ is derived and used to calculate S/sub infinity/ for $^{232}$Th, $^{233}$U, $^{235}$U, $^{238}$U, and $^{239}$Pu. Results are given and discussed. (WHK)

**27984** (INS-J-151) OPTIMUM DEVELOPMENT TEMPERATURE AND DURATION FOR NUCLEAR PLATE. Nagoshi, C. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). 28 Apr 1975. 23p. Dep. NTIS (US Sales Only) $4.25.

Sakura 100 μm thick nuclear plates have been employed to determine optimum temperature and duration of the Amidol developer for low energy protons (Ep ≤ 30 MeV). Development

temperatures of 18, 20, 22 and 24°C were tried for periods of 15 ~ 35 min. For Ep ≤ 25 MeV, the best results were obtained at 18°C and for development time less than 30 min. (auth)

**27985** (INT-64/E) BATTERY STRIP CHART REACTOR. Wolski, K. (Institute of Physics and Nuclear Techniques, Krakow (Poland)). 1975. 12p. (In Polish). Dep. NTIS (US Sales Only) $4.00.

The Battery Strip Chart Recorder (BRK) is a portable, servo-driven instrument designed for slowly changing d.c. voltage measurements and recording. This instrument operates from 12 V d.c. line as well as from the external battery pack. The typical application of the recorder described is the analog recording of data obtained in the in-field radiometric measurements. (auth)

**27986** (JINR-12-7382) PROPERTIES OF PLASTIC SCINTILLATORS PRODUCED BY THE METHOD OF INITIATED POLYMERIZATION IN THE PRESENCE OF BENZOYL PEROXIDE. Golutvina, I. G.; Zhil'tsova, L. Ya.; Matveeva, E. N.; Rubina, O. G.; Stoletova, I. M.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 16p. (In Russian). INIS.

The properties of plastic scintillators, obtained by polymerization initiated in the presence of benzoyl peroxide, were studied. The initiator had a favorable effect on the stability of the scintillation and optical properties. The use of up to 0.1 wt % benzoyl peroxide is recommended for making these scintillators which will be reliable in use. (tr-auth)

**27987** (JINR-13-7861) EFFECT OF ELECTRIC FIELD ON SCINTILLATIONS EXCITED IN LIQUID SCINTILLATORS BY IONIZING RADIATION. Nozdrin, A. A.; Shelkov, G. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 19p. (In Russian). INIS.

The effect of a constant and a pulsed electric field on the amplitude of scintillations activated by alpha and gamma radiation in a standard liquid scintillator based on toluene was studied. The amplitude of scintillation was shown not to depend on the value of the electric field with a potential up to 50 kV/cm. The amplitude of the scintillation after 100 μsec and 2 msec after input of a high-voltage pulse of length 150 nsec and 1.5 μsec, respectively, did not change in time and did not depend on the tension of the pulsed electric field up to 80 kV cm. (tr-auth)

**27988** (JINR-13-7955) TIME CHARACTERISTICS OF THE SCINTILLATION DETECTORS (REVIEW). Part 1. Time Characteristics of Photoelectron Multipliers. Basiladze, S. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 20p. (In Russian). INIS.

Literature data on the factors determining the precision and rate of recording time information using scintillation radiation detectors are discussed. The basic parameters of domestic and foreign photomultipliers, data on time scattering of photoelectrons and secondary electrons, intermittent evacuation, charging (frequency) properties, and noise of photomultipliers are presented. (INIS)

**27989** (JINR-13-7957) TIME CHARACTERISTICS OF THE SCINTILLATION COUNTERS (REVIEW). II. Basiladze, S. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 19p. (In Russian). INIS.

Literature data on factors determining precision and rate of recording of time information with a scintillation radiation detector are discussed. Schemes are presented for connecting up photomultipliers, and experimental results on intermittent vacuum in scintillation detectors are given. The effect of scintillator and light pipe dimensions on an intermittent vacuum is discussed. The basic properties of several scintillators are stated. (tr-auth)

**27990** (JINR-P13-9000) DIGITALLY CONTROLLED MODULES WITH SWITCHING DIODES. Kollar, D.; Kollarova, L.; Luptak, P.; Strait, V.; Horvath, P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Digitally controlled CAMAC modules, using switching diodes-delay, attenuator and switch-multiplexer, are described. They are intended for automatic control of the delays in the channels of the coincidence units with resolving time about 1 ns. (auth)

**27991** (LA-UR-75-1070) MONITORING TRITIUM IN AIR CONTAINING OTHER BETA-EMITTERS USING ION CHAMBERS. Jalbert, R. A. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 19p. (CONF-751101-9). Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A flow-through ionization chamber instrument is described which is capable of measuring tritium in air containing high concentrations of other beta emitters. The instrument employs a separate concentric chamber with a thin common wall opaque only to tritium betas. Currents produced in the two chambers are subtracted leaving only the current due to tritium. With a 1.6-l sampling chamber and an 18-s time constant, tritium concentrations of $10^{-3}$ mu Ci/ml to $10^{-4}$ mu Ci/ml are measured with 2 sigma confidence in background beta concentrations of $4 \times 10^{-3}$ mu Ci/ml to 0.4 mu Ci/ml, respectively. (auth)

**27992** (ORNL-TM-4982) OPTIMIZATION OF RC-CR FILTERS FOR PROCESSING CURRENT PULSES FROM A FISSION COUNTER OPERATING IN A HIGH GAMMA BACKGROUND. De Lorenzo, J. T. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 32p. AT.

The measured, gamma-noise spectrum from an experimental model, high temperature fission counter was studied to determine the optimum RC-CR filter for processing current pulses from the counter. Noise-to-signal ratios, computed using conventional analysis techniques, agreed closely with experimental data. The effect of a pole-zero network, with its zero positioned at or near the pole created by the capacitance of the counter and the impedance of the signal cable, was also studied. Although circuit analysis of this network showed that rejection of gamma background noise would be slightly poorer than that obtainable with the RC-CR filters alone, experimental data obtained with generators to simulate gamma noise and neutron pulses showed a slightly better rejection by the network. (auth)

**27993** STUDY OF THERMAL NEUTRON CURRENTS NEAR CYLINDRICAL ABSORBERS LOCATED IN HEAVY WATER. Simard, Y. N. Toronto; University of Toronto(1973). vp. National Library of Canada, Ottawa.

Thesis (Ph. D.).

The experiments reported in this Thesis involved determining the angular response of detectors to neutrons exterior to the surface of long cylindrical absorbers immersed in a scattering medium. The sources of neutrons were respectively $^{241}_{95}$Am-Be and $^{226}_{88}$Ra-Be, and in certain cases, natural uranium fission. The absorbers consisted of solid cylinders of copper, cadmium or natural uranium in a fuel lattice, and combinations of copper and cadmium, as well as voided cylinders. The scattering (moderating) medium consisted of heavy water. The detectors consisted of long, cadmium shielded and collimated, indium wires activated by exposure to thermal neutrons originating from the sources. The detector response was differential in the transverse plane, but averaged in the axial plane, giving effectively two-dimensional angular distributions. The experimental equipment was located in the University of Toronto Subcritical Reactor assembly, and experiments were carried out with and without the assembly's natural uranium fuel lattice. The indium wire activities were determined by scintillation detector counting methods. In addition to these angular response measurements, fine structure data were also obtained for the moderator. At the inception of the study, it was not known whether the subcritical nature of the assembly, the low source-strengths, the low fluxes, the high non-uniformity in flux distribution and the problems of counting statistics would permit useful results for average angular current to be extracted. It transpired that errors were of the order of 5 to 10%, justifying the approximate approach of the mixed diffusion and transport theory, but not the more accurate full-transport theory analysis. The work paves the way to more sensitive experiments at high fluxes in critical assemblies. (Diss. Abstr. Int., B)

**27994** NaI(Tl) DETECTOR EFFICIENCY CALCULATIONS FOR DISTRIBUTED SOURCES IN A HUMAN PHANTOM. Andrasi, A.; Koetel, G. (Kozponti Fizikai Kutato Intezet, Budapest). Int. J. Appl. Radiat. Isot.; 26: No. 8, 451-454(Aug 1975).

An efficiency calculation method of NaI(Tl)-scintillation detectors has been developed for distributed sources, which is suitable for the calibration of whole-body counters. The full energy peak efficiency of the detector of the whole-body counter used at the Central Research Institute for Physics of the Hungarian Academy of Sciences was determined for a BOMAB human phantom. The peak-to-total ratio was experimentally measured and calculated data were checked by measurements. The relative difference between the calculated and measured full energy peak efficiency values was less than 10% for those energies and measuring geometries investigated. (auth)

**27995** APPARATUS AND METHOD FOR THE DETECTION AND MEASUREMENT OF RADIOACTIVITY IN THE HUMAN BODY. Petit-Clerc, Y. (to Sherbrooke Univ.). British Patent 1,389,672/B/. 3 Apr 1975. Filed date 29 Oct 1971. 12p.

Many devices are available for forming an image of radioactivity distribution in the human body, but a problem associated

with the use of these devices is the difficulty in viewing sources of radioactivity that may be hidden by overlying areas of radioactivity. Most methods of detection and measurement of radioisotope distributions in the human body give a measurement of the mean radioactivity over a large depth; this greatly reduces the contrast and decreases the potential of the method. Furthermore, most devices suffer from excessive detection sensitivity outside the plane of focusing, and secondary effects such as Compton diffusion in the tissues, absorption in the tissues, and penetration of $\gamma$-radiation through collimator walls, tend to render measurements very imprecise. An improved detecting apparatus and method is described which overcomes these and other disadvantages, and gives increased depth resolution, as well as high sensitivity. Accurate measurement of local activity is given, even in the presence of a uniform radioactive distribution around the location of interest. (auth)

**27996** DETECTION OF ALPHA PARTICLES WITH A CHANNEL ELECTRON MULTIPLIER. Zironi, E. P. (Mexican Inst. of Petroleum, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 23: FA13-FA17(1974).

The output pulse of a curved Bendix Channel Electron Multiplier, excited with alpha particle radiation from a 3$\mu$c $^{241}$Am source is studied. The characteristic curve shows a smoothly increasing plateau containing the operating point between 2400 and 2600 V, and the total number of counts changes with the vacuum pressure. Also a shift in the pulse height spectrum appears according to the applied high voltage. (auth)

**27997** SENSITIVITY OF ORGANIC LIQUID SCINTILLATORS TO MAGNETIC FIELDS. Jeenicke, E.; Liaud, P.; Vignon, B.; Wilson, R. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). Nucl. Instrum. Methods; 126: No. 3, 459-463(15 Jun 1975).

The scintillation efficiency of organic, mineral-oil-base scintillator (NE 235) has been measured as a function of applied magnetic fields smaller than 50 G. Below a threshold of 1 G this scintillator is insensitive to magnetic fields (less than $10^{-5}$/G change in scintillation efficiency). Above this threshold, the efficiency of the scintillator rises rapidly, the increase in efficiency reaches 1.5% at 40 G, and saturates around 100 G to a value of 1.8%. (auth)

**27998** KEROSINE SCINTILLATOR. Yamakoshi, K. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). Nucl. Instrum. Methods; 126: No. 3, 407-412(15 Jun 1975).

For the purposes of extensive air-shower observations and guard counting of low-background radiation detectors, large-volume detectors are necessary, therefore efficient liquid scintillators having characteristics such as low cost, high flash point, low chemical aggressivity, and relatively high pulse height are desired. Liquid paraffin, Shellsol-71, kerosene, refined kerosene decalin, Hisol 100, and Hisol 150 were examined as scintillator solvents. Kerosene is one of the most suitable solvents for the purposes mentioned above. Deoxygenated kerosene containing 3.0 g/l DPO, 0.02 g/l POPOP, and 64 g/l naphthalene has a scintillation efficiency of 0.47 that of anthracene. (auth)

**27999** SIMULTANEOUS DETECTION OF A MASS SPECTRUM USING A CHANNELTRON ELECTRON MULTIPLIER ARRAY. Tuithof, H. H.; Boerboom, A. J. H.; Meuzelaar, H. L. C. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). Int. J. Mass Spectrom. Ion Phys.; 17: No. 3, 299-307(Jul 1975).

A simultaneous ion detector is described, consisting of a channeltron electron multiplier array with phosphor screen and a vidicon-multichannel analyser combination. Conversion factors and resolutions of the different components were measured. The detector system allows 100 equidistant ion line images to be resolved at 10% valley definition. Ion currents of minimally $3 \cdot 10^{-16}$ A could be monitored directly at the cathode ray tube (CRT) screen; the minimum number of ions necessary to produce a detectable peak is approximately 220. Spectra of krypton and xenon, obtained with a single focussing magnetic instrument, show a maximum ratio of simultaneously detectable masses of 1.16 and a 2% peak amplitude accuracy. Potentially, the new detector could find wide application in the analysis of minute sample quantities, in the recording of extremely short lasting ion events and in the alignment or focussing improvement of ion optical apparatus. (auth)

**28000** ORGANIC-SCINTILLATOR PULSE-SHAPE DISCRIMINATOR SIGNATURES ASSOCIATED WITH HIGH-ENERGY NEUTRONS. St. Onge, R.; Galonsky, A.; Jolly, R. K.; Amos, T. M. (Michigan State Univ., East Lansing (USA). Cyclotron Lab.). Nucl. Instrum. Methods; 126: No. 3, 391-395(15 Jun 1975).

A two-dimensional system of pulse-shape discrimination (PSD) is described as applied to neutron time-of-flight experiments. When the detector is irradiated with neutrons and gamma rays from 40-MeV proton bombardment of $^{7}$Li, five different PSD signatures are observed - one associated with gamma rays, four with neutrons. The origins of these groups are explained and their importance in neutron detection is discussed. (auth)

**28001** IMPROVEMENTS IN OR RELATING TO GAMMA CAMERAS. Mallard, J. R.; Mitchell, J. G.; Wilks, R. J. (to National Research Development Corp.). British Patent 1,394,053/B/. 14 May 1975. Filed Date 21 Apr 1971. 5p.

The instrument described includes a scintillating screen that emits visible light when bombarded with $\gamma$ radiation, means for directing the light on to an image intensifying device, means for collecting at the periphery of the screen light totally internally reflected from the screen and for directing it into at least one photomultiplier, and means responsive to the photomultiplier output for switching on the image intensifier so that the latter is operated only in response to a predetermined amount of radiation reaching the photomultiplier. The means for collecting the light comprises a translucent body surrounding the periphery of the scintillation screen. This translucent body has a frustoconical surface at which light collected from the scintillation screen is totally internally reflected to the photomultipliers. A high refractive index coupling fluid is interposed in the gaps between the scintillation screen and the translucent body. The photomultiplier may have its cathode embedded in the translucent body. A fibre optic system is used for directing light emitted from the scintillation screen to the image intensifier. (UK)

**28002** METHOD AND APPARATUS FOR LOCALIZATION AND INDICATION OF RADIATION SOURCES. Blum, A. S. German (FRG) Patent 2,328,386/S/. 2 Jan 1975. 21p. (In German).

A method is given which improves the localization and indication of radiation sources with numerous radiation emissions which are given off by dispersed radiation materials of unknown position. Previously stored calibrations of various radiation sources are compared here with present measurements. (GE)

**28003** RADIATION SCANNING SYSTEM. Richey, J. B. (to Ohio Nuclear, Inc.). German (FRG) Patent 2,413,041/S/. 20 Mar 1975. 21p. (In German).

In the making of scintigrams, scanners or cameras may be used. While scanners require a large time expenditure, the resolution power suffers with cameras as a result of the large distance between the photomultiplier and the scintillation crystal, as not all of the photons are detected by the multiplier. Taking the shortest possible distance, the maximum number of photons are detected, but the resulting spatial distortions and irregularities of the scintillations must be electronically corrected. For spatial localization, at least 3 of the parallel arranged multipliers must spot a scintillation. The localization is carried out electronically by means of diode circuit or other non-linear compensation devices. In order to avoid artefact in the observation field, it is necessary to change the distinct onset of the diode current by parallel connection of resistances and to apply bias. The achieved regularity of the field is essential for an improved discrimination of radioactively labelled positions. (GE)

**28004** NUCLEAR RADIATION DETECTOR. Gleason, C. H.; Bamford, A. J.; Gillies, W. (to Westinghouse Electric Corp.). German (FRG) Patent 2,430,296/A/. 23 Jan 1975. 9p. (In German).

A new proportional detector for neutrons is described. It consists of a discharge-limiting piston with a boron lining. The piston is filled with carbon dioxide which dissociates under the influence of the radiation emitted by the neutron absorber. The piston is connected to a filling-gas reservoir which is largely shielded against this radiation. The advantages of this type of neutron counter are its long service life and its applicability in extremely high neutron fluxes. (GE)

**28005** USE OF ELECTRONOGRAPHIC TUBES FOR SPECTROPHOTOMETRIC OBSERVATIONS. Mallia, E. A. (National Inst. of Science and Technology, Manila (Philippines). Medical Research Center). Astrophys. Space Sci.; 35: No. 1, L21-L25(Jun 1975).

It is shown that the performance of spectracons is fairly close to the limit set by the photocathode. Image drift appears to be an as yet unresolved problem, at least in the particular tubes available to us. The emulsion characteristics make grain counting difficult to carry out, but for stellar spectra it proved possible to combine low densities with unwidened spectra. In this way one can shorten exposures appreciably compared to more conventional use of spectracons. For spectrophotometry G5 and not L4 is probably the best general purpose emulsion. At low densities the presence of dirt particles in emulsions limits their usefulness. (auth)

**28006** COMPRESSION OF DATA RESULTING FROM PHOTON COUNTERS. Beckers, J. M. (Sacramento Peak Observatory, Air Force Cambridge Research Laboratories, Sunspot, New Mexico 88349, USA). Space Sci. Instrum.; 1: No. 2, 153-159(May 1975).

A method is presented to compress in an efficient way the counts which result from random event detectors such as photon counters. Such a compression permits almost doubling of the transmission rates for this type of data from spacecraft with no significant loss of information. (auth)

**28007** FOCUSSING X-RAY COLLECTOR AND ITS RESPONSE IN FLIGHT. Catura, R. C.; Roethig, D. T. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). Space Sci. Instrum.; 1: No. 2, 141-151 (May 1975).

A singly focussing X-ray reflector system designed for rocket observation if cosmic X-ray sources is described. The reflector has an angular resolution of one arc minute in X-rays. Focussing properties of this reflector as measured in the laboratory with X-rays and visible light are discussed and the response observed as the flight instrument was scanned over the galactic X-ray source, Sco X-1, is presented. (auth)

**28008** COUNTING STATISTICS: IN CONNECTION WITH A RECENT EXPERIMENT. Libert, J. (Mons Univ. (Belgium)). Nucl. Instrum. Methods; 126: No. 4, 589-590(1 Jul 1975). (In French).

A theoretical distribution used in a recent counting-statistics experiment should be restricted to extended dead time and ordinary renewal process. For stationary and shifted processes another expression is derived. (auth)

**28009** SIMPLE THERMOSTAT FOR MEASURING THE TEMPERATURE DEPENDENCE OF PERTURBED ANGULAR CORRELATIONS. Berek, U.; Kreisel, W.; Schneider, H.; Tierno, E. (Giessen Univ. (F.R. Germany). Abt. Grossgeraete (Angewandte Kernphysik)). Nucl. Instrum. Methods; 126: No. 4, 583-585 (1 Jul 1975). (In German).

A thermostat specially adapted for perturbed-angular-correlation measurements in gaseous sources is described. The temperature dependence of the 145 to 58 keV $\gamma$-$\gamma$ angular correlation in $^{121}$I is also included. (auth)

**28010** ENHANCEMENT OF THE FAST-NEUTRON DETECTION EFFICIENCY OF SOLID-STATE NUCLEAR TRACK DETECTORS (SSNTDs). Khan, H. A. (Pakistan Inst. of Nuclear Science and Technology, Rawalpindi). Nucl. Instrum. Methods; 126: No. 4, 557-561(1 Jul 1975).

Experiments have been carried out to enhance the fast-neutron detection efficiency of CA80-15, LR-115, and Makrofol-E Solid-State Nuclear Track Detectors (SSNTDs). The method consists of etching "volume trails" (the latent damage trails lying in the volume of a detector) by providing the etchant through "source channels" (large channels produced by energetic, highly ionizing, heavy charged particles like 10 MeV/nucleon $^{56}Fe^{+22}$ ions). The results show that, under optimum experimental conditions, the fast-neutron detection efficiency of these detectors can be enhanced by about two orders of magnitude. Theoretical estimates of gain in efficiency, $G_\eta$, for various combinations of the length (L) and radius (R) of the "source channel" have been made and compared with those obtained experimentally. (auth)

**28011** SIMPLE METHOD FOR THE AUTOMATIC EVALUATION OF PARTICLE TRACKS IN MICA. Becker, K. (Oak Ridge National Lab., Tenn. (USA)). Nucl. Instrum. Methods; 126: No. 4, 553-555(1 Jul 1975).

It is shown that the perforation created at the impact location of high-LET charged particles, such as fission fragments in thin (~5 to 15 $\mu$m) sheets of etched muscovite mica, can be counted conveniently by an automatic "spark counter" as used previously for track-counting in organic polymer foils. Ancient fission tracks in the mica are annealed by an 800°C treatment. Mica offers advantages in certain applications as an inorganic detector which can be scanned easily by non-optical means, because of the high thermal stability of the latent tracks (>500°C) and excellent discrimination against low-LET particles. (auth)

**28012** PARTICLE-GAMMA ANGULAR-CORRELATION MEASUREMENT SYSTEM FOR HIGH COUNTING RATES. Abramson, E.; Birk, M.; Vager, Z. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). Nucl. Instrum. Methods; 126: No. 4, 529-534(1 Jul 1975).

A system employing four semiconductor detectors and four NaI(Tl) scintillation counters for particle-gamma angular-correlation measurements at high counting rates is described. Scintillation counter pulses are shaped into rectangular pulses of 200 ns duration in order to reduce pile-up effects, and a compensation circuit for gain variation with rate is used. A fast decision-making logic unit employing MECL 10000 I.C.'s controls data transfer into an on-line PDP-9 computer. Dead-time losses are measured using a pulse-pair generator simulating particle-gamma coincident pulses. In an experiment with 5 to 8 MeV protons and 0.5 to 2.5 MeV gamma rays at a counting rate of approximately 100,000 cps at each of the scintillation counters, the gamma-energy resolution (fwhm) was 6 to 9%; depending on gamma energy, and the time resolution (fwhm) was 1.8 ns. Plots of typical results are shown. (auth)

**28013** DETERMINATION OF THE EFFICIENCY AND ANGULAR DIRECTIVITY OF COSMIC $\gamma$-RAY DETECTORS. Golenetskii, S. V.; Il'inskii, V. N.; Mazets, E. P. Cosmic Res.; 12: No. 5, 706-712(1974).

Translated from Kosm. Issled.; 12: No. 5, 779-786(1974).

A procedure for calibrating the scintillation detector used in the $\gamma$-ray spectrometer on the Kosmos 461 satellite is described. Over a wide energy range, values are determined for the total efficiency of recording $\gamma$ rays and the photoefficiency and photoresponse when the detector is irradiated by an isotropic flux or a parallel beam. The procedure can also be used to calibrate detectors of more complex design, incorporating active and passive collimators and shields. The angular directivity properties of detectors are discussed. It would be possible to design a system of detectors capable of establishing the direction toward a radiation source to within a few degrees. Such a system could be employed to investigate bursts of cosmic $\gamma$ rays. (auth)

**28014** MICROPHOTOMETRY AS A TOOL FOR AUTOMATIC SCANNING OF SOLID STATE NUCLEAR TRACK DETECTORS. Kienzler, B.; Polig, E. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Strahlenbiologie). Radiat. Environ. Biophys.; 12: No. 1, 77-80(Jun 1975).

2 figs.; 5 refs.

By use of a scanning microphotometer the light transmission with both dark field and bright field illumination was determined as a function of the $\alpha$-track density on cellulose nitrate detectors. The so obtained calibration curves allow a rapid measurement of the number of tracks per field and, thus, of the dose rate. To illustrate the application of the method, a scan of a detector exposed on a bone section of a rat injected with $^{241}$Am is presented. (auth)

**28015** NOMOGRAPH FOR DETERMINATION OF MOBILITY-TRAPPING TIME (mu tau) PRODUCT USING NUCLEAR TECHNIQUES. Serreze, H. B.; Entine, G. (Mobil Tyco Solar Energy Corporation, Waltham, MA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 4, 1995-1996(Aug 1975).

A nomograph which can expedite the calculation of mobility-trapping time (mu tau) product from alpha-particle measurement of semiconductor nuclear radiation detector materials is presented. Scale ranges are selected specifically for CdTe, but the nomograph is basically unrestricted in use. (auth)

**28016** EFFICIENCY OF $^{8}$Be DETECTION USING POSITION SENSITIVE DETECTORS. Menchaca-Rocha, A. (Nuclear Physics Lab., Oxford). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 4, 1997-2000(Aug 1975).

The efficiency is calculated for the $^{8}$Be detection method of Wozniak, Jelley and Cerny involving position detectors. A development of the technique is proposed which considerably increases the detection efficiency. (auth)

**28017** THE RE-ENTRANT IONIZATION CHAMBER AS A SECONDARY STANDARD FOR MEASURING THE NEUTRON OUTPUT OF $^{252}$Cf SOURCES. Sundara Rao, I. S.; Pushpangadan, K. D.; Venkataraman, G. (Bhabha Atomic Research Centre, Bombay (India)). Nucl. Instrum. Methods; 127: No. 1, 83-85 (15 Jul 1975).

The use of nitrogen-filled re-entrant-type ionization chamber as a secondary standard for measuring the neutron yields of encapsulated $^{252}$Cf sources used in hospitals is suggested. (auth)

**28018** ETCHING BEHAVIOR OF THE LEXAN POLYCARBONATE PLASTIC DETECTOR. Enge, W.; Grabisch, K.; Dallmeyer, L.; Bartholomae, K. P.; Beaujean, R. (Kiel Univ. (F. R. Germany). Inst. fuer Reine und Angewandte Kernphysik). Nucl. Instrum. Methods; 127: No. 1, 125-135(15 Jul 1975).

The etching mechanism of Lexan Polycarbonate plastic — represented by the bulk etching rate $v_b$ and the track etching $v_t$ — was studied under the variation of the etching parameters like temperature T, etchants, normalities N, and mechanical stirring. The influence of the etchants LiOH, NaOH, and KOH at various normalities (1N-13N) and different temperatures (50°-80°C) was analyzed. Using NaOH the bulk etching rate as well as the track etching rate are described by empirical function $v_b$(N,T) and $v_t$(REL, N, T). The normalized track etching rate $v$(REL) =

$\nu_t$(REL, N, T)/$\nu_g$(N,T) depends only on the restricted energy loss REL and not on the temperature or normality. The charge and isotopic resolution do not change with different etching conditions of NaOH over a wide range (4N-8N, 50°–80°C). At 70°C the stirring of the etchant has no effect on the track-etching rate, and inside of an etch cone the etchant is saturated with etch products. (auth)

**28019** A γ-MONITORING ASSEMBLY FOR THE ANALYSIS FOR FISSION PRODUCTS IN REPROCESSING STREAMS. Marathe, S. G.; Rao, V. K.; Bhargava, V. K.; Iyer, R. H.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India). Radiochemistry Div.). Nucl. Instrum. Methods; 127: No. 1, 99-103 (15 Jul 1975).

The design, fabrication, and operational details of a gamma-monitoring assembly consisting of a movable shielded NaI(Tl) detector, a stainless-steel flow cell, a remotely operated aluminium disc with lead absorbers, and an electrical readout system is described. The system is useful for continuous monitoring of fuel-reprocessing streams for gross as well as individual fission-product activities. Gross activities in the range 5 mCi/l to 15 Ci/l can be monitored continuously with an accuracy of 10 to 20%. Mixtures of two or three of the major fission products $^{95}$Zr-$^{95}$Nb, $^{106}$Ru($^{106}$Rh), $^{137}$Cs($^{137m}$Ba), $^{144}$Ce($^{144}$Pr), commonly encountered in long-cooled irradiated fuel, can also be analyzed within an uncertainty of 15 to 20%. (auth)

**28020** THE ZEBRA MULTI-CHAMBER SCANNING SYSTEM. Batt, R. G.; Goodings, A.; Marshall, J.; Sanders, J. E.; Sweet, D. W. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Nucl. Instrum. Methods; 127: No. 1, 47-51(15 Jul 1975).

The Multi-Chamber Scanning System developed for the zero-energy fast reactor Zebra comprises an integral array of 150 fission chambers providing a rapid three-dimensional power-mapping facility. The paper describes the basic concept, the design and calibration of the fission chambers, the electronics and computer interface, and overall performance in a mock-up of the Prototype Fast Reactor. (auth)

**28021** MULTIWIRE PROPORTIONAL CHAMBER FOCAL-PLANE DETECTOR. Beardsworth, E.; Fischer, J.; Iwata, S.; Levine, M. J.; Radeka, V.; Thorn, C. E. (Brookhaven National Lab., Upton, N. Y. (USA)). Nucl. Instrum. Methods; 127: No. 1, 29-39(15 Jul 1975).

Multiwire proportional chambers with precise position resolution were developed utilizing external-tapped delay-line readout from a cathode and simultaneous dE/dx information from the anode for identification of particles ranging from protons to heavy ions in the focal plane of a high-resolution magnetic spectrometer (QDDD). A resolution of less than 0.2 mm fwhm was achieved for 48 MeV $^{16}$O ions. (auth)

## *Radiation Dosimeters*

*Refer also to abstracts 28095, 28141–28143, 28154, and 28309.*

**28022** (AECL-5040) WARNING DOSIMETER WITH A DIGITAL MEMORY. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Apr 1975. 22p. (CONF-750707-6). Dep. NTIS (US Sales Only) $4.25. AECL $0.50.

From annual meeting of the Health Physics Society; Buffalo, New York, USA (13 Jul 1975).

The dosimeter warns the wearer when exposed to γ-rays, providing an audible pulse for every 0.4 mrad absorbed. When a dose of about 0.5, 0.4, 0.3 or 0.2 rad (according to an internal interconnexion) has been absorbed the audible pulses change to a continuous tone and a red warning lamp lights. The warning level is independent of dose rate in the range 1 mrad/h to 100 rad/h and also of ambient temperature in the range –10 to +50°C. The stand-by battery life is 6,000 hours. The application and calibration of the dosimeter are discussed. (auth)

**28023** (IEA–365) PHOTO-TRANSFERRED THERMOLUMINESCENCE (PTTL) IN LiF TLD-100. Sunta, C. M.; Watanabe, S. (Instituto de Energie Atomica, Sao Paulo (Brazil)). Dec 1974. 16p. Dep. NTIS (US Sales Only) $4.00.

This paper presents an experimental study on PTTL in LiF TLD-100. PTTL is studied as a function of residual TL, wave length of UV light, and temperature of sample during UV exposure. The following results are obtained: (1) The relative intensities of individual glow peaks in PTTL glow curve are remarkably different from those of X or gamma ray induced TL glow curve. The intensity changes are so drastic that peaks 1, 2 and 3 can be stronger than peak 5. (2) The efficiency of transfer per unit photon fluence has a maximum value for 230 to 240 nm light in all the samples studied which indicates that one of the residual traps from where charge transfer occurs resembles closely F and $Z_3$ centres. Charge transfer from another residual trap is most effective with 290 nm light. (3) The intensity of PTTL is not proportional to the total residual TL of a sample. It appears that the efficiency of transfer from different types of residual traps is different. Also different residual traps redistribute their optically released charge carriers preferentially amongst the available empty traps. (4) The transfer efficiency is very much dependent on temperature of the sample during UV exposure. This shows that charge release from residual trap is partly by UV photon energy and partly under thermal stimulation. The UV photon excites the charge carrier from residual trap to an intermediate level close to but below the free state from where thermal stimulation liberates it into the free state. This thermal energy gap is computed to be 0.12 eV. (auth)

**28024** (IEA–372) BACK-SCATTER AND BUILDING-UP EFFECTS ON THE THERMOLUMINESCENCE SENSITIVITY OF A THERMAL NEUTRON MONITOR. Nakajima, T.; Totti, V.; Watanabe, S.; Fujimoto, K.; Maung, S.; Nishimura, A. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jan 1975. 10p. Dep. NTIS (US Sales Only) $4.00.

The thermal neutron monitoring system used with ordinary thermoluminescence dosimeters has been studied. In this monitoring system, we used the capture gamma rays from the reaction between cadmium and thermal neutrons. The effects of the back scatter and building up of radiation have been studied for approaching the n/γ ratio of the system to that of the mixed field. It has been found that the ratio of a system using these effects is greater than that of one without these effects and that the minimum measurable fluence is about $10^8$ n/cm$^2$. This method can be used for all kinds of thermoluminescence dosimeter phosphors. (auth)

**28025** (INIS-mf-1407) COBALT BOROSILICATE GLASS DOSIMETER. Bongirwar, D. R. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 14p. (CONF-730495-4). INIS.

From 1st annual conference of Indian association for radiation protection; Bombay, India (12 Apr 1973).

The cobalt borosilicate glass dosimeters type F-0621 could be extensively used in radiation dosimetry work and other radiation processing operations where dose measurements are necessary. Once the relationships in the form of equations were available (from computer) between the optical density readings and radiation dosages, for particular type of glass dosimeter, the same could be used for all further work. The fading could be overcome by delaying the optical density measurements by 24 hours. The same glass dosimeters could be reused again and again after annealing; as a result the dosimeters could be saved. Three different wavelengths viz., 350, 400 and 500 m should be used for optical density measurements depending on the dose ranges, to obtain good linear response. The glass dosimeters are quite handy and could be taken over anywhere without any difficulty. (auth)

**28026** LUMINESCENCE DOSIMETRY USING SODIUM FLUORIDE SINGLE CRYSTALS. Datta, S. (Imperial Coll. of Science and Tech., London); Hughes, A. E. Health Phys.; 29: No. 3, 420-421(Sep 1975).

The use of M centres in sodium fluoride as a radiophotoluminescent dosimeter system has been investigated using the 365 nm line of a mercury arc to excite the luminescence via the $M_F$ absorption band. Results show that M centre fluorescence can be used as a dosimeter system for ionizing radiation with a lower detection limit of about 10 rads but the response is not perfectly linear over the range 10 to $10^6$ rads, and depends somewhat on the origin of the crystals used. Even with improved experimental techniques it would be difficult to achieve the <100 mrad sensitivity to ionizing radiation possible with modern radiophotoluminescent glasses. (UK)

**28027** DOSE MEASUREMENT OF FAST ELECTRONS WITH A MODIFIED FRICKE SOLUTION. Nemec, H. W.; Roth, J.; Luethy, H. (Kantonsspital Basel (Switzerland). Abt. fuer Radiologische Physik). Strahlentherapie; 149: No. 5, 493-498(May 1975). (In German).

A combination of two different modifications indicated in the literature about the ferrosulfate dosimetry is given. This permits a dose measurement which shows the following advantages: dose specification related to water; displacement of the absorption maximum in the perceptible spectral sphere; increase of the sensibility and lower influence of pollutions. The molar coefficient of extinction of the modified solution has been determined from $^{60}$Co gamma irradiation and is $\epsilon_m = 1.46 \times 10^4 \times \text{Mol}^{-1} \times \text{cm}^{-1}$. The increase of extinction which has been measured with this method after the irradiation with 18 MeV electrons occurs linearly within the studied region to 1,200 rd at least, the G-value is 15.5. The indicated method renders possible a relatively simple calibration of ionization chambers. (auth)

**28028** MEASUREMENT OF FAST-NEUTRON DOSE USING A PROTON-RECOIL TELESCOPE. Williams, A. (National Physical Lab., Teddington (UK)). Nucl. Instrum. Methods; 126: No. 4, 595(1 Jul 1975).

A method of measuring fast-neutron dose in hydrogen is proposed which relies on measuring the energy of the protons emitted from an hydrogenous radiator in a proton-recoil telescope. (auth)

**28029** SUPERLINEARITY AND RE-EVALUATION OF DIFFERENT LiF DOSIMETER TYPES. Piesch, E.; Burgkhardt, B.; Kabadjova, S. (Kernforschungszentrum Karlsruhe (F.R. Germany)). Nucl. Instrum. Methods; 126: No. 4, 563-572(1 Jul 1975).

LiF ribbons and LiF-teflon dosimeters of different thicknesses were investigated in the dose range 10 to $10^6$ R after exposure with $^{137}Cs$ gamma rays and thermal neutrons. A low supralinearity for thermal neutrons of about 15%, but different shape of supralinearity for TLD 600 and TLD 700 as well as for LiF-teflon dosimeters of the same type but different batches were found, with a maximum response in the region of $5 \times 10^4$ R and $10^4$ R, respectively. A second evaluation of LiF-teflon dosimeter leads-contrary to LiF ribbons—to a residual dosimeter reading which is not proportional to the exposure because of an increase of supralinearity at higher doses and the formation of additional low-temperature glow peaks, even after exposure to a low dose. (auth)

**28030** APPLICATIONS OF THE MEGARAI DOSEMETER. Gruenewald, T. (Bundesforschungsanstalt fuer Ernaehrung, Karlsruhe (F. R. Germany). Inst. fuer Strahlentechnologie). G-I-T (Glas- Instrum.-Tech.) Fachz. Lab.; 19: No. 4, 307-310 (1975). (In German).

The Megarai colour dosemeter is used for a visual check-up as to whether sterilization by irradiation has taken place. However, it can also serve to measure a dose of irradiation below 1 Mrad: alterations in the graph of reflection at 550 nm can be measured with a photometer. Trichromatic measurement, too, yields usable calibration curves in this range. (auth)

**28031** DOSISMESSVERFAHREN IN DER RADIOLOGISCHEN TECHNIK. Eisensulfatdosimetrie. Entwurf. (Procedures in Dosimetry. Ferrous Sulfate Dosimetry. Draft). Berlin; Beuth (Feb 1975). 6p.

Scope, range of applications measuring principle, composition and production of the titrant, irradiation vessels, determination of the concentration of substances, correlation between the energy dose in the titrant and the concentration of substances, calculation of the energy dose in the neighbouring material, directional dependence, and errors are reviewed. (GE)

**28032** DOSISMESSVERFAHREN IN DER RADIOLOGISCHEN TECHNIK. Filmdosimetrie. Entwurf. (Procedures in Dosimetry. Film Dosimetry. Draft). Berlin; Beuth (Feb 1975). 5p.

Scope, range of use, measuring principle, film material, film development and handling, film density, characteristic film curve, fading, calibration and dose conversion, energy and directional dependence, film envelope, influence of the dose rate, and errors are reviewed. (GE)

**28033** DOSISMESSVERFAHREN IN DER RADIOLOGISCHEN TECHNIK. Radio-Thermolumineszenz-Dosimetrie. Entwurf. (Procedures in Dosimetry. Radio-Thermoluminescence Dosimetry. Draft). Berlin; Beuth (Feb 1975). 4p.

Scope, range of application measuring principle, thermoluminescent materials for dosimetry, heating curves, background, fading, calibration, dose conversion, energy and directional dependence, probe regeneration, radiation damage, and errors are reviewed. (GE)

**28034** DOSISMESSVERFAHREN IN DER RADIOLOGISCHEN TECHNIK. Radio-lumineszenz-Dosimetrie. Entwurf. (Procedures in Dosimetry. Radio-Photoluminescence Dosimetry. Draft). Berlin; Beuth (Feb 1975). 4p.

Scope, range of application, measuring principle, phosphate glasses, background, fading, temperature effect, calibration, dose conversion, energy and directional dependence, probe regeneration, and errors are reviewed. (GE)

**28035** DOSISMESSVERFAHREN IN DER RADIOLOGISCHEN TECHNIK. Ionisationsdosimetrie. Entwurf. (Procedures in Dosimetry. Ionization Dosimetry. Draft). Berlin; Beuth (Feb 1975). 10p.

Scope, measuring principle, range of applications, layout of an ionization dosemeter, types of ionization chambers, free-air ionization chambers for photon and electron radiation, absolute counting of the ion dose, calibration, energy and directional dependence, dose conversion, and sources of error are reviewed. (GE)

**28036** DOSISMESSVERFAHREN IN DER RADIOLOGISCHEN TECHNIK. Allgemeines Zur Dosimetrie Von Photonen- und Elektronenstrahlung Nach der Sondenmethode. Entwurf. (Procedures in Dosimetry. Principles of Photon and Electron Dosimetry with Probe-Type Detectors. Draft). Berlin; Beuth (Feb 1975). 7p.

The role of the probe method in dosimetry and descriptions of probes, monitoring systems, probe dose and probe factor, types of probe and dose conversion factors such as errors and corrections are reviewed. (GE)

**28037** MEASUREMENT OF THE SURFACE DOSE AND THE CALIBRATION OF SOFT X-RAY DOSIMETERS. Sundara Rao, I. S.; Naik, S. B. (Bhabha Atomic Research Center, Bombay (India). Radiological Protection Div.). Strahlentherapie; 149: No. 6, 578-584(Jun 1975).

A method is presented for calibrating the commercial soft x-ray dosimeters against a device which measures back-scatter contribution in addition to the ionization produced by direct radiation. The calibration of these dosimeters directly in terms of surface dose in rad offers greater convenience for routine use, relieving the physicists of some routine calculations. The details of construction of the surface chamber and the results of calibration of a soft x-ray chamber, also designed in this laboratory, are presented. (auth)

**28038** THERMOLUMINESCENCE OF X-RAY IRRADIATED POLYCRYSTALLINE $Al_2O_3$ POWDER. Das, B. N. (Indian Inst. of Tech., Kharagpur). J. Mater. Sci.; 10: No. 7, 1246-1248 (Jul 1975).

A study was made of the possibility of using polycrystalline $Al_2O_3$ powder as x-ray dosimetry material. A typical thermoluminescent glow curve of polycrystalline $Al_2O_3$ powder, irradiated with x rays, is shown. The growth of the three glow peaks (at 192, 240, and 340°C) with time of x ray irradiation is also shown. Results are discussed. (UK)

**28039** COMPARISON STUDY OF ENVIRONMENTAL DOSIMETER SYSTEMS UNDER FIELD CONDITION AT A SEMITROPICAL SITE. Weng, P. S. (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Sci. J. (Taiwan); 12: No. 2, 61-68(Jun 1975).

Commercially available and self-fabricated thermoluminescent dosimeters were tested under field conditions at a site located in a semitropical area for one year. The results of various environmental dosimeter systems are discussed. The effect of the monitoring stick was investigated, and the replacement of the bamboo stick with plastic tubing is proposed. Once again the self-fabricated thermoluminescent dosimeters pass the field test in addition to the international intercomparison program held in 1974. (auth)

**28040** THE EFFECTS OF HIGH GAMMA DOSES ON THE RESPONSE OF PLASTIC TRACK DETECTORS. Khan, H. A.; Atta, M. A.; Yameen, S.; Haroon, M. R.; Husain, A. (Pakistan Inst. of Nuclear Science and Technology, Rawalpindi). Nucl. Instrum. Methods; 127: No. 1, 105-108(15 Jul 1975).

Systematic studies have been made concerning the effects of high doses of gamma rays on the track-registration properties of various plastic Solid State Track Detectors (SSTDs). The detectors were first exposed to $^{252}Cf$ fission fragments and then to gamma doses ranging between 30 and 160 megarad. The results show that both the length and the width of latent damage trails are affected when exposed to gamma doses of the order of a few megarads. Furthermore, it was found that the general etching velocity, Vg, increases with increasing gamma dose. The above mentioned results suggest that: (a) gamma doses below the megarad region do not affect the track-registration characteristics of plastic SSTDs, and (b) the change in track parameters (in the megarad region) can be employed as an index of gamma dose. This new type of gamma dosimeter, due mostly to its extremely small size and flexibility, offers greater advantages over other detectors for in-core gamma dosimetry. (auth)

**28041** LATENT FADING OF MONITORING FILMS. Bartlett, D. T.; Creasey, F. L. (National Radiological Protection Board, Harwell (UK)). Nucl. Instrum. Methods; 127: No. 1, 149(15 Jul 1975).

In the United Kingdom the National Radiological Protection Board operates a four-weekly issue Fast Neutron Personal Monitoring Service without unacceptable fading problems. (auth)

**28042** APPARATUS FOR MEASURING THE THERMOLUMINESCENCE OF SMALL SAMPLES. Brou, R. (Caen Univ., 14 (France). Lab. de Physique Corpusculaire); Valladas, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Dept. de Physique des Particules Elementaires). Nucl. Instrum. Methods; 127: No. 1, 109-113(15 Jul 1975). (In French).

A description is given of an apparatus for thermoluminescence experiments with the following special features: a constant speed

of heating up to 500°C; ability to reach 800°C for in situ annealing of minerals being studied; ability to change to a neutral atmosphere due to the small volume of the chamber; cooling time less than one minute; a paraboloidal mirror allowing an output parallel light beam and the use of interference filters. (auth)

**28043** RADIOGRAPHY OF LOW-ENERGY ION BEAMS: HYDROGEN COLORATION OF FLINT GLASSES. Primak, W. (Argonne National Lab., Ill. (USA)). Nucl. Instrum. Methods; 127: No. 1, 21-22(15 Jul 1975).

Optical flint glasses (i.e., lead containing) develop an intense coloration when subjected to bombardment with protons or deuterons. The coloration is sufficient for the detection and measurement of ion beams penetrating less than a micron. The optical absorption is given as a function of wavelength and appears to be the tail of bands centered in the near ultraviolet. The optical density at 0.436 mu m is given as a function of incident ion charge for 140 keV protons and deuterons and for 80 keV protons. Initially, the rate of coloration appears to be the same for two different flint glasses and for all the ions, hence proportional to the number of implanted ions. (auth)

## *Nuclear Spectroscopic Instrumentation*

*Refer also to abstracts 28739 and 30406.*

**28044** (INIS-mf-1232) NEW AUTOMATIC SPECTROMETER FOR THE γ-RAY FLUORESCENCE. Arad, D. (Institute of Electrical and Electronics Engineers (IEEE). Israel Section). 1973. vp. (In Hebrew). (CONF-730496-1). INIS.

From 8th convention of electrical and electronics engineers; Tel Aviv, Israel (30 Apr 1973).

**28045** (JINR-E10-9059) ABOUT ONE METHOD FOR PROCESSING DISCRETE ENERGY SPECTRA WITH COMPLEX PEAK SHAPE. Zlokazov, V. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1975. 15p. Dep. NTIS (US Sales Only) $4.00.

A new method for processing discrete energy spectra is described. It uses a notion of peak pattern, which may be given either by an analytical function or by a table of numbers. This pattern is connected with real peaks by some simple relations, so that whatever the sophisticated peak shape is, only 3 parameters are required for estimation of peak area, position, and width. The method is most suitable for the analysis of spectra containing the overlapped peaks having the shape with non-Gaussian asymmetry. (auth)

**28046** (JINR-P3-8904) RESOLUTION FUNCTION DETERMINATION FOR DIFFRACTOMETER OVER TIME OF FLIGHT. Baiorek, A.; Georgiu, Z.; Kornee, D. A.; Kulya, R.; Popovich, M.; Stoika, A. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 23p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

The results of experimental test of formulae for the calculation of the resolution functions in neutron spectrometry have been presented. Using an ideal single crystal there was measured the resolution function of a diffractometer over time-of-flight. The experimental data have been compared with the theoretical formulae. (auth)

**28047** (JINR-R-10-7614) RAPID PROCESSING OF γ-SPECTRA WITH MINI COMPUTERS. Gopych, P. M.; Khabenikht, V.; Khan, B.; Ehler, G.; Vinel, G.; Vylova, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 11p. (In Russian). INIS.

A complex program was written for rapid preliminary processing of γ spectra with a digital computer. The computer is controlled by dialog through a screened panel, which allows ready storage and processing of data and obtaining of results during the time of the experiment. (tr-auth)

**28048** (UCRL-76693) ADVANCED INSTRUMENTATION FOR NUCLEAR MONITORING. Armantrout, G.; McGibbon, A.; Swierkowski, S.; Sherohman, J.; Yee, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Sep 1975. 13p. (CONF-751017-11). Dep. NTIS $4.00.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

Research on semiconductor radiation detectors is described. Computational models to calculate the energy band structure, carrier mobility, and carrier lifetime of proposed detector materials are presented; and a computer spectrum simulation that accurately predicts the potential performance of the materials as detectors is given. Also, a self contained, field-portable spectrometer for laboratory-grade pulse-height analysis of gamma-ray spectra suitable for use under extreme environmental conditions and isolated locations by personnel not trained in electronics is reported. (auth)

**28049** LEAST-SQUARES RESOLUTION OF GAMMA SPECTRA ON A PDP-11 COMPUTER. I. ALPHA-T for NaI Spectra. II. Resolving Multiplets in Ge(Li) Spectra. Kelley, M. T. (Tennecomp Systems, Inc., Oak Ridge, TN). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 4-5(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**28050** AN ON-LINE MULTICHANNEL ELECTRON SPECTROMETER WITH HIGH TRANSMISSION. Lindblad, T.; Linden, C. G. (Forskningsinstitutet foer Atomfysik, Stockholm (Sweden)). Nucl. Instrum. Methods; 126: No. 3, 397-406(15 Jun 1975).

A high-transmission electron spectrometer has been designed to study conversion electrons in the decay following (particle, Xn) reactions. A solenoidal magnetic field is used to transport the electrons away from the target and focus them on a cooled Si(Li) detector. The latter is situated about half a meter from the target, thus reducing the background due to electrons from γ-rays as well as the background which is due to scattered particles significantly. The energy resolution of the spectrometer is about 2.0 keV at electron energies of 500 keV. Spectra obtained from bombarding various targets with 48-51 MeV alpha particles are presented. (auth)

**28051** BROAD-RANGE STEPPED-POLE MAGNETIC SPECTROGRAPH. Basargin, Yu. G.; Boldin, N. I.; Korolev, L. E.; Levchenko, V. G.; Severgin, Yu. P. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)); Gofman, Yu. V.; Maidikov, V. Z. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). Nucl. Instrum. Methods; 126: No. 3, 413-416(15 Jun 1975).

A broad-range magnetic spectrograph for the analysis of nuclear scattering and reaction products was constructed and preliminarily tested. The spectrograph is able to record simultaneously the particles of which the momenta differ by a factor of 2.6. The new type of the pole structure (stepped poles) allows one to obtain an effective solid angle of about 5 msr at $Bp \leq 1.25$ Tm. The device was tested using a standard alpha source. A simulation of a simultaneous recording of non-relativistic particles differing in energy by a factor of 5 was carried out. A momentum resolution of about $10^{-3}$ was obtained with source dimensions of $3 \times 10$ mm$^2$. (auth)

**28052** N-TYPE CdTe SEMICONDUCTOR DETECTORS AS X- AND LOW-ENERGY GAMMA-RAY ROOM-TEMPERATURE SPECTROMETERS. Dabrowski, A. J.; Iwanczyk, J. (Institute of Nuclear Research, Warsaw (Poland)); Triboulet, R. (Centre National de la Recherche Scientifique, 92 - Meudon-Bellevue (France). Lab. de Magnetisme et de Physique du Solide). Nucl. Instrum. Methods; 126: No. 3, 417-420(15 Jun 1975).

Surface-barrier detectors produced from n-type CdTe ingots highly purified by the sealed-ingot-zone refining method have been investigated as room-temperature x- and low-energy gamma-ray spectrometers. X-ray spectra of various elements from Fe to Tm are presented. Energy resolutions of 4.6 keV (fwhm) for $^{241}$Am (59.5 keV), and 2.6 keV (fwhm) for 9.9 keV characteristic K x-rays from Ge have been found. (auth)

**28053** PRINCIPLES OF REVERSE NEUTRON TIME-OF-FLIGHT SPECTROMETRY WITH FOURIER CHOPPER APPLICATIONS. Poeyry, H.; Hiismaeki, P.; Virjo, A. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Reaktorilaboratorio). Nucl. Instrum. Methods; 126: No. 3, 421-433(15 Jun 1975).

In all methods so far devised for neutron time-of-flight analysis, the measured spectrum is obtained by recording the detected neutron intensity during constant periods triggered by a start signal which is synchronized with the modulation pattern periodically applied to the incident neutron beam. The spectrum can, however, be formed in a reverse manner as well, by recording a properly delayed digital analogue of the modulation function during periods triggered by the detected neutrons. A thorough analysis of the new technique, called the reverse time-of-flight method, is presented. It is shown that the method corresponds to an on-line procedure, in which the observed spectrum is constructed by cross-correlating the detected neutron intensity with the modulation pattern of the chopper used. No external on-line correlator is needed for this purpose. The reverse method applies to any of the chopper types familiar from ordinary "forward" time-of-flight techniques, i.e. Fermi type, pseudostatistical or Fourier-type choppers, but its on-line capability is particularly useful with a Fourier chopper, since by varying the modulation frequency in a suitable way during the measurement one can obtain the desired time-of-flight spectrum directly without complicated off-line calculations typical of the forward Fourier method. Another interesting feature of the reverse Fourier method is that it allows spectrum filtering with a

single chopper. If the off-time of the chopper is finite, the statistical error in the non-filtered parts of the spectrum may be reduced significantly. (auth)

**28054** REVERSE TIME-OF-FLIGHT TEST FACILITY FOR NEUTRON-DIFFRACTION STUDIES. Hiismaeki, P.; Junttila, J.; Piirto, A. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Reaktorilaboratorio). Nucl. Instrum. Methods; 126: No. 3, 435-443(15 Jun 1975).

A description is given of an experimental test facility aimed at obtaining practical experience on the reverse time-of-flight techniques. Special attention is paid to the computer-based data-processing system and the construction of a Fourier chopper operated at maximum speed of 7000 r.p.m., corresponding to 100 kHz modulation of the neutron beam. Test measurements on single crystals are reviewed confirming the expected relative widths of the order of 0.1% for the diffraction peaks. Finally, various aspects of a reverse time-of-flight diffractometer are discussed. (auth)

**28055** PROPOSAL FOR A NEW QUASI-ELASTIC SCATTERING SPECTROMETER. Hiismaeki, P.; Leikkonen, I.; Tiitta, A. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Reaktorilaboratorio). Nucl. Instrum. Methods; 126: No. 3, 445-452 (15 Jun 1975).

A new focusing time-of-flight spectrometer, suitable especially to quasi-elastic scattering studies is proposed. The main constituents of the proposal are a Fourier chopper operated according to the reverse time-of-flight principle and a curved crystal. A focusing condition is derived which does not depend on the order of a Bragg reflection of the crystal. Normally several orders can thus be measured simultaneously with subsequent increase in the efficiency. Sometimes it may be more advisable to eliminate the higher orders with the aid of a polycrystalline filter. Various applications of the proposed spectrometer are discussed. (auth)

**28056** INTERPRETATION AND MEASUREMENT OF DATA. Chapman, B. G. (to United Kingdom Atomic Energy Authority). British Patent 1,395,753/B/. 29 May 1975. Filed Date 23 Feb 1972. 4p.

Apparatus is described for use in interpreting data obtained in radiochemical analysis. When a sample is exposed to a radiation detector and the pulse height distribution obtained is divided into pulse energy increments, or so called channels, the graphical result is a spectrum of energies superimposed on a background of noise, and resolution of the spectrum is a difficult and tedious operation unless costly and complex apparatus is available. The apparatus described aims to provide a cheap and effective means of measuring areas contained by selected peaks of an energy spectrum in the presence of noise, with an accuracy acceptable for most purposes. The apparatus operates in conjunction with a pulse height analyzer of the multi-channel type, and provides means whereby selected channels may be successively integrated and the integration plotted as a substantially continuous curve but with individual spectrum peaks being identifiable as discrete parts of the curve. The radiation detector comprises a Li-drifted Ge diode. There is no need to take background noise into account. (UK)

**28057** FAST ZERO-TIME DETECTOR FOR TIME-OF-FLIGHT MEASUREMENTS WITH HEAVY IONS. Lang, W.; Clerc, H. G. (Technische Univ. Darmstadt (F.R. Germany). Inst. fuer Kernphysik). Nucl. Instrum. Methods; 126: No. 4, 535-539(1 Jul 1975).

Two variants of a zero-time detector for heavy ions using secondary electrons emitted by a thin carbon foil are described. The secondary electrons are accelerated in a parallel-plate geometry and detected by a surface-barrier detector. With the carbon foil inclined to the beam axis by 62°, a time resolution (fwhm) of 280 ps was obtained for $^{252}$Cf-fission products. With the foil oriented perpendicular to the beam axis, the system is especially suited for slow particles with a large beam diameter. A time resolution of 370 ps was obtained at 8 mm beam diameter. (auth)

**28058** ACCURACY OF MEASUREMENTS OF A NEUTRON SPECTRUM BY MEANS OF A CONVENTIONAL AND A CORRELATION CHOPPER. Graffstein, A. (Institute of Nuclear Research, Warsaw (Poland)). Nucl. Instrum. Methods; 126: No. 4, 495-507(1 Jul 1975).

The accuracy of measurements performed by use of the correlation or the conventional chopper is considered. The new decoding method based on a calculated decoding sequence is used. In the calculations statistical and Monte-Carlo methods are employed. The influence of the background on the accuracy of the measurements is shown on graphs. (auth)

**28059** ABSOLUTE EVALUATION METHODS IN X-RAY SPECTROMETRY. Plesch, R. (Siemens A. G., Karlsruhe (F. R. Germany). Geschaeftsbereich Mess- und Prozesstechnik). Z. Anal. Chem.; 275: No. 2, 97-102(Jun 1975). (In German). 4 figs.; 2 tab.; 8 refs.

In practice it can be necessary to receive the whole stock of informations given by the standard samples. The usual evaluation of the gross intensities is in these cases not sufficient, but it is necessary to measure the net intensity of each standard sample and to use these values for the fitting of the measurement results. A further improvement is possible by a ratio method which largely eliminates the matrix influences. The size of this improvement depends on the quality of the standard samples. (auth)

**28060** NEW PRECISE DETERMINATION OF THE COINCIDENCE LOSSES FOR A $\gamma$-COUNTING SYSTEM IN THE ENTIRE COUNT RATE RANGE WITH TWO $\gamma$ SOURCES. Ujhelyi, C. (Inst of Nuclear Research, Debrecen, Hungary). ATOMKI (At. Kut. Intez.) Kozl.; 17: No. 2, 147-169(1975).

A series of observed-to-true net count rate ratios, $R/R^0 < 1$, can be experimentally evaluated by the "count-rate ratio" method proposed. The $\gamma$-sources S and $S_1$ differ only in their true net count rates (cps), $R^0$ and $R_1^0$. The precise value of $R^0/R_1^0 \geq 10$ can be experimentally determined. The observed source-plus-background rates for sources S and $S_1$, $R + R_b$ and $R_1 + R_b$, are counted separately in the same position. A set of the observed net cps ratios $R/R_1$ can be obtained by changing the distance between the detector and the sources. From a series of values $q = (R/R_1)/(R^0/R_1^0) < 1$ the resolving time $\tau$ of the entire $\gamma$-counting system can be evaluated from the relationship $\{q[1 - \tau(R_1 + 2R_b)]\}^* = 1 - \tau(R + R_b + qR_b)$, which is correct in the linear portion of the q vs. R curve. Therefore, the method includes the determination of the cps range, where the equation $(R/R^0)^* = 1 - \tau(R + R_b + qR_b)$, which is an alternative form of $(R + R_b)/(R^0 + R_b^0) = 1 - \tau(R + R_b)$, is strictly valid. On the other hand, it is suitable to evaluate the values of $R/R^0$ at such high count rates R, where $R/R^0 \leq 1 - \tau(R + R_b + qR_b)$. The experimental values of $R/R^0$ can be estimated from the equation $R/R^0 = q[1 - \tau(R_1 + 2R_b)]$. At higher values of $R_1$, where $R_1/R_1^0 \leq 1 - \tau(R_1 + 2R_b)$, the values of $R_1/R_1^0$ may be derived from a graph of $R/R^0$ vs.R. (auth)

**28061** A BALLOON-BORNE Ge(Li) SPECTROMETER FOR GAMMA-RAY ASTRONOMY. Jacobson, A. S.; Bishop, R. J.; Culp, G. W.; Jung, L.; Mahoney, W. A.; Willett, J. B. (Jet Propulsion Lab., Pasadena, Calif. (USA)). Nucl. Instrum. Methods; 127: No. 1, 115-124(15 Jul 1975).

On June 10, 1974, a new high-resolution gamma ray spectrometer operating in the energy range of 0.05 to 10 MeV was successfully balloon-flight tested. This sytem uses four 40 cm$^3$ Ge(Li) crystals in a single cryostat as prime sensors. A 6.35 cm thick CsI (Na) shield provides background rejection and collimation, defining a solid angle of 0.095 sr. Cooling is provided by a liquid-nitrogen dewar. The system was highly stable with spectral resolution of better than 2.5 keV at 1 MeV for the flight duration. The background total count rate was about 20 counts/s. Numerous lines were observed, most of which originated from secondary neutron interactions in the spectrometer. The sensitivity of the system to line emissions originating in cosmic point sources is $10^{-4}$-$10^{-3}$ photons/cm$^2$s over the energy range. (auth)

**28062** A NEW MAGNETIC FILTER FOR INTERNAL-CONVERSION STUDIES WITH A Si(Li) DETECTOR. Ishii, M. (Division of Physics, Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken, Japan). Nucl. Instrum. Methods; 127: No. 1, 53-59(15 Jul 1975).

A new magnetic filter has been constructed which is employed with a Si(Li) detector in electron spectroscopy. The filter consists of thin rectangular permanent magnets arrayed in an orange form around a lead shield. It transmits 0.5% or more of electrons in the energy range 300 to 1000 keV. A Si(Li) detector combined with it suppresses the influence of direct gamma rays emitted from the source by factors of 300 for 500 keV gamma rays, and 25 for 1 MeV ones. Thus the combined system is well suited for a study of internal-conversion electrons which follow nuclear excitations induced by positron decay (including orbital electron capture) and charged-particle reactions. (auth)

**28063** THE CALIBRATION OF $^6$Li SEMICONDUCTOR SANDWICH SPECTROMETERS. Clements, P. J. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Nucl. Instrum. Methods; 127: No. 1, 61-72(15 Jul 1975).

The $^6$Li Semiconductor Sandwich Spectrometers which are commonly used for the measurement of fast-neutron spectra, especially in reactors, are subject to a variety of effects which, if not taken into account, can lead to significant calibration errors. The effects which are here discussed in detail are: (1) the energy degradation in the sensitive layer of the spectrometer, (2) the alpha-particle contribution to the "response function" used to deconvolve the lower-energy part of the neutron spectra, and

(3) the superposition of a high-energy contribution on the lower part of the measured spectrum in one mode of operation of the spectrometer. It will be shown that the failure to take account of these effects can in some circumstances lead to energy-calibration errors of ~30 keV and errors of up to 50% in measured neutron spectra. (auth)

**28064** ANALYTIC APPROXIMATIONS TO PEAK SHAPES PRODUCED BY Ge(Li) AND Si(Li) SPECTROMETERS. McNelles, L. A ; Campbell, J. L. (Guelph Univ., Ontario (Canada). Dept. of Physics). Nucl. Instrum. Methods; 127: No. 1, 73-81(15 Jul 1975).

Accurate analytical descriptions of peaks in Ge(Li) and Si(Li) detectors are important in various areas of current interest. A variety of functional forms is tested using a coaxial Ge(Li) detector and a guard-ring Si(Li) detector to provide experimental data. A two-component description of the tailing is necessary for the Ge(Li) detector, while a one-component description suffices for the Si(Li). (auth)

## *High Energy Physics Instrumentation*

**28065** (CERN-Trans-74-1) DYNAMICS OF A VAPOR BUBBLE IN HELIUM AND HYDROGEN ULTRASONIC CHAMBERS. Tkachev, L. G.; Shestakov, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Mar 1974. 13p. (JINR-R-13-7206). INIS.

Translation from the Russian.

The results are presented of experimental and theoretical investigations of track formation in a liquid-hydrogen bubble chamber in the ultrasonic field. Different physical phenomena are considered characterising the dynamics of the vapor pockets. The dynamics of the nucleating bubble is studied: cavitation and diffusion thresholds are determined as well as the dependence on the initial phase and surface tension. (auth)

**28066** (IFVE-SEF-74-106) EFFICIENT LOGIC NANOSECOND ELECTRONICS. Bushnin, Yu. B.; Krasnokutskij, R. N.; Mikhajlov, Yu. V.; Shuvalov, R. S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1974. 12p. (In Russian). INIS.

A system of nuclear electronics is described for experiments in high-energy physics. The system consists of three standard units (strobe, memory, and function). Twelve logical functions can be obtained from the signals from 32 counters. When a large number of units are used, the system can be broadened both at the input and the output. The system was constructed according to the pulsed potential principle, which permits decreasing the number of radioparts and joined components, increasing the reliability, and simplifying the use. (tr-auth)

**28067** (IFVE-SVM/SPK/SEF-74-89) PATCHY SYSTEM FOR THE DIRECT ACCESS PAM-FILES. Belokopytov, Yu. A.; Kaminskij, L. G.; Klimenko, S. V.; Lebedev, A. A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1974. 15p. (In Russian). INIS.

The PATCHY system of storage and editing of texts of large programs used at JINR is described. The system is used for processing units from a bubble chamber. It is combined with a visual system used at CERN but is 7 to 10 times as fast. The system uses a special punched card. The program is in FORTRAN. (INIS)

**28068** (ISS-L-74/8) HIGH-ENERGY BEAMS AND MAGNETIC SPECTROMETERS. Part II. Matthiae, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 20 Aug 1974. 65p. (In Italian). Dep. NTIS (US Sales Only) $6.25.

In these lectures the properties of dipole and quadrupole magnets are discussed together with their combined use in beam transport systems. Commonly used methods of magnetic analysis are reviewed. Several examples of charged particle spectrometers are discussed. (auth)

**28069** (JINR-10-7966) PROGRAMS OF DATA COLLECTION AND PROCESSING FROM FILMLESS WIRE CHAMBERS OF THE 5m SPARK SPECTROMETER MIS JINR. Vishnyakov, V. V.; Zajmidoroga, O. A.; Ivan'shin, Yu. I.; Ivanov, V. V.; Ivanchenko, I. M.; Karpenko, N. N.; Kuznetsov, V. N.; Pakhomov, V. L.; Chvyrov, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1974. 17p. (In Russian). INIS.

A program for processing experimental data with spark chambers at JINR is described. This system of programs permits taking, superimposing, and monitoring experimental information with the wire chambers of a 5-meter spark spectrometer. (tr-auth)

**28070** (JINR-11-7941) OPERATION SYSTEM FOR THE SPIRAL MEASURER CONTROL COMPUTER. Kotov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1974. 23p. (In Russian). INIS.

A dispatcher for operational systems of the "spiral measurer" automatic scanner is described. The dispatcher program ensures a shift in the discipline of maintenance of orders from the electronic equipment of the spiral measurer both with relative priority for inserting the program of maintenance of discontinuity and with absolute priorities for the basic programs operating with authorized intermittency. The effectiveness of selected dispatching disciplines is estimated. (tr-auth)

**28071** (JINR-11-7942) MULTIPLEXER FOR THE DIRECT ACCESS INTO THE OPERATING MEMORY CHANNEL OF THE SPIRAL MEASURER CONTROL COMPUTER. Kotov, V. M.; Ponyatovskij, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1974. 16p. (In Russian). INIS.

A multiplier for the primary access channel in an operative memory of a control computer that is part of a scanning automated set-up, the "spiral gage," is described. The apparatus allows operating 15 external structural units in separate time regimes. (tr-auth)

**28072** (JINR-P13-8867) TRACK DETECTION IN A HYDROGEN SELF-SHUNTED STREAMER CHAMBER. Busso, L.; Kulyukin, M. M.; Lyashenko, V. I.; Troshev, T. M.; Falomkin, I. V.; Shcherbakov, Yu. A.; Nguen Minh Kao, Pontekorvo, D. B.; Piradzhino, G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 19p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Pictures of electron tracks in a streamer chamber filled with hydrogen at pressures from 200 torr up to atmospheric pressure have been obtained. The tracks were observed in a self-shunted chamber. Small admixtures of methane were used. The investigation has been performed at the Laboratory of Nuclear Problems, JINR. (auth)

**28073** (JINR-R-13-7811) APPARATUS FOR THE CONTROL OF THE 2m STREAMER CHAMBER OPERATING CONDITIONS. Volodin, V. D.; Matyushin, V. T.; Glagoleva, N. S.; Kuznetsov, P. S.; Matyushin, A. T.; Shevchenko, Eh. N.; Olejnichak, V.; Firkovskij, R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1974. 23p. (In Russian). INIS.

Apparatus for monitoring the regime of a streamer chamber to ensure continuous control of the parameters with a high-voltage pulse on the electrodes—amplitude, length, delay—is described. Absolute values of the tension of a field in the chamber were measured with a precision of 5 to 7%. The advantages of construction of electron apparatus for experiments on an accelerator in the form of a functionally closed system of electron equipment located on a moving platform is presented. (tr-auth)

**28074** (KFTI-74-21) CHARGED PARTICLE TRACK SIMULATION IN A BUBBLE CHAMBER. Vajsfel'd, A. M.; Egorova, I. E.; Lyubarskii, G. Ya. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 8p. (In Russian). INIS.

An algorithm and a program are described for modeling the tracks of charged particles in a bubble chamber. Attention is especially given to calculating the average radiation power and its fluctuations and to methods of selecting points on the track. Two methods were developed: (1) selection of points using an oscillograph and a light pencil; (2) a programmed method of irregular selection which allows an increase in density of the selected points at the beginning of the track. (tr-auth)

**28075** SCINTILLATING DRIFT CHAMBER: A NEW TOOL FOR HIGH ACCURACY, VERY-HIGH-RATE PARTICLE LOCALIZATION. Charpak, G.; Majewski, S.; Sauli, F. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Instrum. Methods; 126: No. 3, 381-389(15 Jun 1975).

A drift chamber is described where a photomultiplier detects the photons emitted by the electrons drifting in a strong electric field in a short gap at the end of the drift space. Accuracies below 300 $\mu$m are obtained. The absence of space charge leads to considerable high-rate capabilities; at $2 \times 10^6$/s mm$^2$ no change of characteristics is observed. Self-triggering models have been investigated and various applications are discussed. (auth)

**28076** STREAMER-CHAMBER DETECTOR AT THE CERN INTERSECTING STORAGE RINGS. Eggert, K.; Thome, W. (Technische Hochschule Aachen (F.R. Germany). 3. Physikalisches Inst.); Betev, B.; Bohm, G.; Darriulat, P.; Dittmann, P.; Gygi, E.; Holder, M.; McDonald, K. T.; Pugh, H. G. Nucl. Instrum. Methods; 126: No. 4, 477-491(1 Jul 1975).

The design, construction, and performance of a streamer-chamber system for the study of inelastic proton-proton collisions at the CERN ISR are described. The chambers have specially shaped ground electrodes to accommodate the ISR vacuum chamber and to obtain an almost $4\pi$ solid angle. Problems arising from the non-flat electrodes and the insertion of converter plates into the sensitive volume of the chambers are discussed. The high-voltage and gas system are described and in particular the control system for the streamer-chamber memory time which is essential for operation at high ISR luminosities. The optical system, including single-stage electrostatic image intensifiers, is explained. The chambers are triggered on inelastic beam-beam interactions with counter hodoscopes, or on interactions including a photon which is detected in a lead-glass Cherenkov counter located at 90°. Finally the analysis of the pictures is described. (auth)

**28077** PRINCIPLES AND FEASIBILITY OF AN OPTICAL PREPROCESSOR IN HIGH-ENERGY PHYSICS. Perrin, M.; Metzger, G. (Centre National de la Recherche Scientifique, 67—Strasbourg (France). Lab. de Physique du Noyau et de Physique des Particules). Nucl. Instrum. Methods; 126: No. 4, 509-518(1 Jul 1975).

The results of a feasibility study on optical processors intended for high-energy-physics data reduction in an off-line mode are given. The basic principle is to use the frequency domain rather than the spatial domain to recognize sparks aligned along a track as a first approximation for event reconstruction. This makes use of the optical Fourier transform in a first stage, and of matched filtering techniques in a second stage. A simulation on a Univac 1108 computer of the optical processors is done. Theoretical interpretation of the results and a brief experimental comparison is made. The construction problems are discussed. (auth)

**28078** MEMORY-LEVEL DECISION FOR A 50000-WIRE PROPORTIONAL-CHAMBER DETECTOR. Brandt, A.; Dibon, H.; Fluegge, G.; Niebergall, F.; Schubert, K. R.; Schumacher, P. E.; Wilmsen, W. (Hamburg Univ. (F.R. Germany). 2. Inst. fuer Experimentalphysik). Nucl. Instrum. Methods; 126: No. 4, 519-527(1 Jul 1975).

A memory-level decision logic used at the CERN-ISR Split Field Magnet Detector is described. 50000 wires of the multiwire proportional chamber detector are grouped into 32-wire memory OR levels, corresponding to 64 mm space resolution. From their pattern, the topology of specific events is defined. The rejection power for wrong events is of the order of $10^2$ to $10^3$. The decision time is about 1 $\mu$s. (auth)

**28079** NEW LEAD GLASSES FOR CHERENKOV COUNTERS. Yoshimura, Y.; Maki, A. (National Lab. for High Energy Physics, Oho, Ibaraki (Japan)); Suzuki, I.; Matsukawa, M.; Ohuchi, F.; Komorita, F. (Ohara Optical Glass Mfg. Co. Ltd., Sagamihara City, Japan); Ono, M.; Nakano, I.; Hemmi, Y.; Miyake, K. (Kyoto Univ. (Japan). Dept. of Physics). Nucl. Instrum. Methods; 126: No. 4, 541-547(1 Jul 1975).

Attempts have been made to improve the characteristics of glasses suitable for Cherenkov counters of the total-absorption type. Many kinds of new lead glasses were prepared and examined in the transmittance, radiation lengths, and methods of manufacturing. Several kinds of glass blocks having the dimension of $65 \times 65 \times 235$ mm$^3$ were manufactured successfully. The transmittance of one of the new glasses is higher than the usual lead glass of F-2. It was also found that the discoloration of the new glasses is smaller than the usual lead glasses upon irradiation of $^{60}$Co $\gamma$ rays of $10^4$ to $10^7$ Roentgens. The Cherenkov counters of the total-absorption type with the new glasses, together with the ones with usual glasses of F-2, SF-2, SF-5, and SF-6, were tested by using electron beams with energies from 300 to 1000 MeV. It was found that the energy resolution of the first ones is better by a few percent than that of the latter in the whole energy region. (auth)

**28080** TRACK DETECTION IN A SELF-SHUNTED HYDROGEN STREAMER CHAMBER. Falomkin, I. V. (Joint Institute for Nuclear Research, Dubna, USSR); Kulyukin, M. M.; Lyashenko, V. I.; Kao, Nguyen Mink; Pontecorvo, G. B.; Troshev, T. M.; Shcherbakov, Yu. A.; Busso, L.; Piragino, G. Lett. Nuovo Cim.; 13: No. 11, 427-431(12 Jul 1975).

The method of obtaining particle tracks in a self-shunted hydrogen streamer chamber is discussed. The effect of the high-voltage pulse width (for pulses longer than a few nanoseconds), gas additives, and pressure are considered. (WHK)

**28081** AN OPTICAL METHOD FOR THE MEASUREMENT OF THE SOUND PRESSURE AMPLITUDE IN AN ULTRASONIC HYDROGEN BUBBLE CHAMBER. Ishihara, N. (National Lab. for High Energy Physics, Oho, Ibaraki (Japan)); Ishii, T.; Fujimura, R. (Tokyo Univ. of Agriculture and Technology, Koganei (Japan). Faculty of Technology); Negishi, K. (Tokyo Univ. (Japan). Inst. of Industrial Science); Ozaki, T.; Kikuchi, J.; Doke, T. (Waseda Univ., Tokyo (Japan). Science and Engineering Research Lab.). Nucl. Instrum. Methods; 127: No. 1, 41-46(15 Jul 1975).

An optical method for measurement of the sound pressure amplitude in the standing-wave field of an ultrasonic hydrogen bubble chamber is described. Although this method gives only an average value of the sound pressure amplitude along the light path in the liquid, the amplitude at the center part in the standing-wave field can be estimated by measuring the lateral distribution of the average value. In this experiment, such a lateral distribution has been measured in the liquid of $CCl_4$, in which the sound velocity is almost the same as that in liquid hydrogen, and the ratio of the sound pressure amplitude at the center part to the average value along the light path has been obtained. Assuming that the ratio is applicable to an ultrasonic hydrogen bubble chamber having the same geometrical conditions as in experiment for $CCl_4$, the sound pressure amplitude at the center part is determined. (auth)

**28082** TRANSITION RADIATION FROM LITHIUM FOILS. Yuan, L. C. L.; Alley, P. W.; Bamberger, A.; Dell, G. F.; Uto, H. (Brookhaven National Lab., Upton, N. Y. (USA)). Nucl. Instrum. Methods; 127: No. 1, 17-20(15 Jul 1975).

The yield of transition radiation is expected to be higher for a low-Z material because of low absorption. Yields of transition radiation from lithium foils have been measured using multiwire proportional chambers and using a thin NaI counter in a beam of electrons and pions from 0.5 to 3.5 GeV/c. The transition radiator consisted of 1000 foils of 2 mil lithium spaced at 20 mils. Results from a lithium radiator are compared with those of Mylar-foil radiators, and the advantages of lithium radiators in applications are discussed. (auth)

**28083** TRANSITION RADIATION FROM 100 TO 250 GeV/c PIONS. Bosshard, R.; Fischer, J.; Iwata, S.; Radeka, V.; Wang, C. L. (Brookhaven National Lab., Upton, N. Y. (USA)); Atac, M. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Nucl. Instrum. Methods; 127: No. 1, 137-139(15 Jul 1975).

X-ray transition radiation from 100 to 250 GeV/c pions passing through either lithium or polypropylene foils was observed with proportional wire chambers. The x-ray intensity increases linearly with the Lorentz factor. Pions and protons at these momenta can be differentiated with a few radiator-detector units. (auth)

**28084** X-RAY TRANSITION RADIATION FROM 50 GeV/c ELECTRONS. Bosshard, R.; Fischer, J.; Iwata, S.; Radeka, V.; Wang, C. L. (Brookhaven National Lab., Upton, N. Y. (USA)); Atac, M. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Nucl. Instrum. Methods; 127: No. 1, 141-143(15 Jul 1975).

X-ray transition radiation from electrons up to 50 GeV traversing lithium foils was studied with xenon-filled proportional wire chambers. The x-ray yield up to the Lorentz factor $10^5$ is consistent with theory. Excellent electron-hadron discrimination was achieved. (auth)

## Radiometric Instruments

*Refer also to abstract 27463.*

**28085** (BISI-13111) THICKNESS MEASURING INSTRUMENTS WITH RADIO-NUCLIDES TO CONTROL STRIP THICKNESS IN COLD ROLLING MILL. Part 1. Carl, W. Translated from Baender, Bleche, Rohre.; 15: No. 4, 146-152(1975). 17p. British Industrial and Scientific International Translation Service, Metals Society, London £7.00.

The control of strip thickness in cold rolling mills requires thickness measuring instruments capable of measuring the thickness of the strip reliably, continuously, rapidly and without contact. Radiometric measuring techniques satisfy all of these requirements. A brief survey of the possibility of controlling strip thickness defects is given in the present Part 1 and is followed by an explanation of essentials and of measuring technology. (UK)

**28086** (N-75-13216) DEVELOPMENT OF AN ALPHA SCATTERING INSTRUMENT FOR HEAVY ELEMENT DETECTION IN SURFACE MATERIALS. Final Report. Turkevich, A. L.; Economou, T.; Blume, E.; Anderson, W. (Chicago Univ., Ill. (USA). Enrico Fermi Inst.). Dec 1974. 50p. (NASA-CR-141009). NTIS $3.75.

The development and characteristics of a portable instrument for detecting and measuring the amounts of lead in painted surfaces are discussed. The instrument is based on the ones used with the alpha scattering experiment on the Surveyor lunar missions. The principles underlying the instrument are described. It

is stated that the performance tests of the instrument were satisfactory. (auth)

**28087** 100-mg $^{252}Cf$ ACTIVATION ANALYSIS FACILITY AT SRL. MacMurdo, K. W.; Bowman, W. W. (E. I. du Pont de Nemours and Co., Aiken, SC). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 28-29(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**28088** DATA REDUCTION IN THE $^{252}Cf$ ACTIVATION ANALYSIS FACILITY AT SRL. Bowman, W. W.; MacMurdo, K. W. (E. I du Pont de Nemours and Co., Aiken, SC). Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 29(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**28089** TESTING DEVICE FOR DOSE RATEMETERS WITH ABSORBING DISKS FOR COMPENSATION OF THE INTENSITY DECREASE WITH TIME OF THE TEST SOURCE. Rutzki, B. (To Frieseke und Hoepfner GmbH). German(FRG) Patent 2,305,675/B/. 14 Aug 1974. 3p. (In German).

A testing device for dosemeters is described. Absorber disks can be inserted into the beam path of the test source to compensate the intensity decrease with time of the test source. (GE)

**28090** DEVICE FOR CALIBRATION AND CONTROL OF RADIOMETRIC MOISTURE MEASURING SYSTEMS FOR BULK MATERIALS. Grieser, F.; Klein, R. (To Mannesmann AG). German(FRG) Patent 2,264,674/A/. 23 Jan 1975. 5p. (In German).

Equipment for the calibration and control of radiometric moisture measuring systems for bulk materials in which the chemical properties of a material give a defined constant moisture value and where a simulated moisture value is reproducibly maintained with a fixed position of the measuring probe plunged in the equipment is characterized in that the cadmium plates of various wall thicknesses or at various depths cladding the measuring probe, absorbing neutrons, which are between the filler and the measuring probe are arranged in a fixed position. (auth)

**28091** IMPROVEMENTS IN OR RELATING TO THE ANALYSIS OF UNCONSOLIDATED MATERIALS. Paske, R. E. A. (to United Kingdom Atomic Energy Authority). British Patent 1,390,551/B/. 16 Apr 1975. Filed Date 16 Mar 1972. 3p.

Reference is made to methods for the measurement of the density of materials such as silts or sludges. It is stated that the usual methods employed are not entirely satisfactory, and a radiometric method is proposed using a probe enclosing a radioactive source, preferably $^{137}Cs$, together with a suitable detector system. The source and detector are arranged in backscatter geometry. The $\gamma$-rays from the source pass into the silt, where they are both scattered and absorbed, the proportion of the radiation detected being a function of the density of the silt, or other material and, to a lesser extent, the composition. A vibratory drive unit is provided to impart longitudinal impulses to the probe. Telemetry is preferably carried out by means of an armoured cable, that also acts as a suspension cable. (UK)

**28092** DUST MEASURING SYSTEM. Dresia, H.; Opel, H.; Spohr, F. (to Krohne (Ludwig) KG). German (FRG) Patent 2,329,247/A/. 2 Jan 1975. 7p. (In German).

A dust measuring equipment which measures the attenuation of $\beta$-radiation due to a layer of dust is described. In the beam path to the detector, a compensation absorber with locally different absorbing powers can be used to compensate for measuring errors. (GE)

**28093** MEASURING WOOL WITH RADIOACTIVITY. Rural Res.; 86: vp(Dec 1974).

A description is given of a new method based on the use of radioisotopes for the measurement of the fibre diameter of wool. Small samples of wool were sealed in a small ampoule with formic acid containing a radioactive isotope and a chemical scintillator. A liquid scintillator was then used to determine the thickness of the wool fibers. (Australia)

**28094** DEVELOPMENT OF MATHEMATICAL MODELS AND THE DUAL-GAUGE PRINCIPLE OF SURFACE-TYPE NEUTRON MOISTURE CONTENT GAUGES. Dunn, W. L.; Gardner, R. P. (North Carolina State Univ., Raleigh (USA). Dept. of Nuclear Engineering). Nucl. Eng. Des.; 32: No. 3, 438-448(1975).

Mathematical models are developed for the response of surface-type neutron moisture content gauges. Models are developed for both cadmium-covered and bare $BF_3$-filled proportional counter detectors so that the dual-gauge principle of measurement can be applied. This consists of the simultaneous solution of the two responses to minimize the effect of variations in sample composition. The response models are based on epithermal and thermal line and area flux models, where if flux as a function of radial distance r from the source is $\phi(r)$, then line flux is $\int\phi(r)\,dr$ and area flux is $\int\phi(r)r\,dr$. The flux models are obtained from a solution of the three-group diffusion equation for a point source of fast neutrons at the surface of an infinite half-space and are expressed as inverse Hankel transforms. The models are checked by calculations and are verified with Monte Carlo and experimental results. To minimize the effects of variations in sample compositions, represented by the weight fraction of thermal neutron absorber, two gauge response models are solved simultaneously for moisture and absorber weight fractions. This application of the dual-gauge principle is tested with experimentally obtained responses on samples of known density and composition. The results of this feasibility study are encouraging in terms of eventual commercial application of the response models and the dual-gauge principle. (auth)

## Radiation Effects on Instrument Components, Instruments, or Electronic Systems

**28095** THERMOLUMINESCENCE OF HIGH DIELECTRIC CONSTANT MATERIALS. Elle, D. R.; Vetter, R. J.; Ziemer, P. L. (Purdue Univ., Lafayette, IN). Health Phys.; 29: No. 1, 220-223(Jul 1975).

Following a preliminary study of the thermoluminescent properties of a number of high dielectric material phosphors, in both the activated and unactivated state, those phosphors showing optimum response versus heating time and activator concentration were investigated for linearity of response and of fading with time. Phosphors thus selected were: $BaTiO_3$ activated with 1 and 0.5 mol % Dy and fired for 16 h; $BaZrO_3$ activated with 1 mol % Dy and fired for 16 h; $(BaSr)TiO_3$ fired for 8 h; and $Ba(TiZr)O_3$ fired for 8 h. Representative glow curves are shown. The combination phosphors demonstrated much less response to gamma irradiation with the maximum response lower by two orders of magnitude than that of the activated phosphors. Use of these phosphors in a ceramic form was also examined. The importance of the data lies in the probable expansion of solid state dosimetry into other regions of the electromagnetic spectrum. (UK)

**28096** ARTIFICIAL RADIOACTIVITY IN DETECTOR SHIELDING PRODUCED BY PROTONS IN THE EARTH'S INNER BELT. Aleksandrov, Yu. A.; Vernov, S. N.; Kuznetsov, S. N.; Logachev, Yu. I. Cosmic Res.; 12: No. 5, 666-669(1974).

Translated from Kosm. Issled.; 12: No. 5, 731-735(1974).

In cosmic-ray measurements at the equator and polar caps at altitudes of 400-2000 km, an increase in the count rate of shielded gas discharge counters above that of counters with less shielding has been observed. This is caused by activation of the shielding by protons from the earth's inner belts. Due to the asymmetry of the radiation belt relative to the center of the earth, the shielded counter indications were dependent on longitude and altitude. An estimate of the half-life of the isotope formed is made. The overcount effect was observed at the equator and the polar caps in the absence of irradiation, which indicates the possible existence of high-energy $\gamma$-quantum fluxes. (auth)

**28097** SECOND BREAKDOWN AND DAMAGE IN 1N4148 FROM OSCILLATING ELECTRICAL TRANSIENTS. Kalab, B. (Harry Diamond Labs., Adelphi, MD). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 4, 2006-2009(Aug 1975).

The conditions for initiating second breakdown in 1N4148 diodes were investigated with reverse-biasing square pulses following high forward injection (prestress). It was found that at a certain prestress the reverse voltage necessary for inducing second breakdown suddenly drops from the normal reverse breakdown voltage to about 20 percent of this value. At higher prestress the power necessary for junction damage from the reverse pulse is higher by more than an order of magnitude than without prestress, and no transition to second breakdown is observed. These results are n t in agreement with present models of second breakdown and junction damage. (auth)

## Miscellaneous Instruments

*Refer also to abstracts 27626, 27730, 27880, and 28749.*

**28098** (COO-2215-1) KRYPTONATE-BASED INSTRUMENTATION DEVELOPMENT FOR AUTOMOBILE EXHAUST POLLU-

TANTS. Phase III Report: Design and Construction of Four (4) Experimental Models. Goodman, P.; Donaghue, T. (Panametrics, Inc., Waltham, Mass. (USA)). [nd]. Contract AT(30-1)-4069. 26p. Dep. NTIS $4.50.

This phase of the program encompasses the design, construction and evaluation of four (4) prototype instruments for the detection of automobile exhaust pollutant. These instruments employ the radio release mechanism utilized by Panametrics in detection of various trace gases. The prototype instruments are of two (2) designs. One design is operable from a power source supplied by an automobile battery. The second design is operable from 110 volts AC power. Successful evaluation in the laboratory as well as with various automobiles were performed with both type instruments. Scale-up of the quantity of sensor material prepared introduced unexpected problems with respect to detection lifetime which were not satisfactorily resolved within the time and funds available to the program. Nevertheless, a Kryptonate-based instrument using a single detection method for the measurement of hydrocarbons, CO and NO/sub x/ as pollutants by automobile exhausts was shown to be operable with actual automobile exhausts, to provide more than adequate sensitivity for inspection purposes, and to provide response and recovery times for full scale reading in the range 10-15 secs. (auth)

**28099** (KFTI-74-33) MONOCRYSTAL PRECISION ORIENTATION AND CUT-OUT TECHNIQUE. Kapcherin, A. S.; Papirov, I. I.; Avotin, S. S. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 10p. (In Russian). INIS.

A complex of adaptors for the diffractometer Dron-1,5 and electroscope stand proposed for precision orientation and notching of monocrystals with a given orientation is described. The precision of the notching is ±30 angular minutes and the subsequent grinding may achieve a precision of 1 to 3 angular minutes. (tr-auth)

**28100** (UCID-16823) PORTABLE MASS SPECTROMETER FOR FIELD AND LABORATORY USE. Newton, J. C.; Crawford, R. W.; Stump, R. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Jul 1975. Contract W-7405-Eng-48. 17p. Dep. NTIS $4.00.

A rugged, portable mass spectrometer is described that can be used for gas analyses in remote areas, yet is suitable for laboratory use. Representative results from several studies, including preshot gas analyses of atmospheres from canisters used in the Cannikin Event, are given. Operational procedures and performance experience are included. (auth)

**28101** MEASUREMENT OF THE IRRADIANCE OF ULTRAVIOLET RADIANCE FOR EXCITATION OF FLUORESCENT TESTING MEDIAS. Stadthaus, M. (Bundesanstalt fuer Materialpruefung, Berlin (F.R. Germany). Fachgruppe Elektrische und Magnetische Pruefverfahren); Dickhaut, E. (Motorenund Turbinen-Union G.m.b.H., Muenchen (F.R. Germany)). Materialpruefung; 17: No. 5, 145-147(May 1975). (In German).

The suitability of commercial instruments for measuring the radiance in the region of 320 to 400 nm (black light) is studied, which is used in nondestructive testing by magnetic particle and penetrant methods with fluorescent testing medias. The application of black-light-meters enables correct judgement of lamps and lamp-arrangements, the description of the fluorescence of testing media, and information about the visibility of indications by inspection personnel. (GE)

**28102** BIPOLAR AUTORANGING FOR A DC AMPLIFIER. Lasser, O. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Nucl. Instrum. Methods; 126: No. 4, 579-581(1 Jul 1975).

Two possibilities of a circuit and its performance for an autoranging dc amplifier for both polarities at the input are described. The circuit has been designed for an amplifier with a short response time and can be adapted to the most various requirements of measuring technique especially for reactor instrumentation. (auth)

**28103** LOW-COST TIME-OF-EVENT RECORDER. O'Sullivan, C. T.; Spillane, M. C.; Twomey, P. J. (Dept of Physics, University College, Cork, Ireland). Nucl. Instrum. Methods; 126: No. 4, 591-593(1 Jul 1975).

A system is described which enables the Universal Time of occurrence of certain events to be recorded. Hourly synchronization of the system by means of standard radio VLF timing signals eliminates the need for expensive clocks. (auth)

**28104** ADVANCES IN TEST MEASUREMENT. Volume 11. Proceedings of the 20th International Instrumentation Symposium Held May 21-23, 1974, in Albuquerque, New Mexico. Washburn, B. (ed.). Instrumentation in the Aerospace Industry. Volume 20. Pittsburgh; Instrument Society of America (1974). 464p. (CONF-740504-).

Fifty-one papers are presented. Separate abstracts were prepared for 6 papers for announcement in ERA and 1 paper for announcement in NSA. (WHK)

*For an abstract of an individual paper see: 30247.*

**28105** TRANSFER OF MULTICHANNEL-ANALYZER DATA TO A MINICOMPUTER. Silverans, R. E. (Louvain Univ. (Belgium)). Nucl. Instrum. Methods; 127: No. 1, 147-148(15 Jul 1975).

A simple method is described to process ASCII-coded data output from a multichannel analyzer interfaced to a DEC PDP-11 mini-computer by means of a BASIC computer program. (auth)

**28106** A SOLID-STATE "LEAKY" INTEGRATOR. Hain, T. F. (Melbourne Univ., Parkville (Australia). School of Physics). Nucl. Instrum. Methods: 127: No. 1, 23-28(15 Jul 1975).

The description of a solid-state "leaky" integrator is given. Beam currents in the range of 1 nA to 10 μA may be processed without the need to change the integration-capacitor-leak-resistor combination. The device has separate timing-pulse outputs for stopping the beam and for time-of-preset activation. A precision of 0.1% is achieved with activities having half lives down to 1 s. This figure degrades to 1% with a 100 ms half life, but can be reduced if necessary. (auth)

**28107** INVESTIGATION OF MICRO-CHANNEL PLATES AS PARALLEL-BORE ELECTRON COLLIMATORS FOR USE IN A PROXIMITY-FOCUSED ULTRA-FAST STREAK TUBE. Lieber, A. J.; Benjamin, R. F.; Sutphin, H. D.; Webb, C. B. (Los Alamos Scientific Lab., N. Mex. (USA)). Nucl. Instrum. Methods; 127: No. 1, 87-92(15 Jul 1975).

Micro-channel plates have been investigated for use as parallel-bore electron collimators for energies up to 10 keV. The collimation quality of plates of three aspect ratios has been measured using a dc beam. Measured angular acceptance profiles indicate good collimation. This investigation was carried out as part of a design study of an ultra-fast proximity-focused streak tube using a micro-channel plate for transverse photoelectron velocity selection. (auth)

# ISOTOPE AND RADIATION SOURCE TECHNOLOGY

## Isotope Separation (Industrial)

*Refer also to abstract 27850.*

**28108** (FOA-C-20023-A1) LASER, NOZZLE, AND MASS DIFFUSION: POSSIBLE ENRICHMENT METHODS FOR URANIUM. Stroemberg, L. G. (Foersvarets Forskningsanstalt, Stockholm (Sweden)). Dec 1974. 51p. (In Swedish). Dep. NTIS (US Sales Only) $5.75.

Three methods for uranium enrichment are discussed, namely enrichment with laser, the German nozzle method and mass diffusion. Laser enrichment is tudied intensively at several places in the world and the nozzle method has lately been developed to an economically competitive alternative. Mass diffusion has earlier been used for enrichment of lighter substances, for example $^{13}C$, but probably not yet for enrichment of uranium. Finally a description is given of the development in the field of enrichment in different countries the last few years. (auth)

**28109** URANIUM ENRICHMENT. Pelser, J. (Stichting Reactor Gentrum Nederland, The Hague). Atoomenerg. Haar Toepass.; 17: No. 6, 134-139(Jun 1975). (In Dutch).

The basic equations of an enrichment stage using molar fractions for feed, product and waste, are defined. A cascade system is analysed in algebraic terms, with special reference to a centrifuge installation, detailed calculation results being tabulated for a cascade with eight enrichment sections ($R_0$ to $R_7$) and five stripper sections ($S_1$ to $S_5$). Optimum waste concentration aspects are considered, from the standpoint of achieving minimum product cost for known values of separative work costs and natural uranium feed costs. An example is given for $42/kg separative work and $34/kg uranium, and for a 100,000 centrifuge cascade producing about 73 kg of 3% enriched uranium. A short note is given of blending economics. (NL)

**28110** URANIUM ENRICHMENT: FORECASTS, PROCESSES, PLANS. Ehrfeld, U. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Kernverfahrenstechnik). Atomwirtsch., Atomtech.; 20: No. 5, 259-261(May 1975). (In German).

From international conference on uranium isotope separation; London, UK (5 Mar 1975).

The development of the demand for enriched uranium with time is hard to predict and realization of the present plans is still in the embryo stage. On a medium-term basis, only the diffusion, ultracentrifuge and separation nozzle processes appear worth considering as methods of uranium enrichment, although some other methods might have a chance to be taken up in the distant future. The main problem in securing the supply, however, is not technology but the financing of new facilities. (auth)

**28111** URANIUM AS AN INDICATOR OF THE ORIGIN OF THE TETHYAN OPHIOLITES. Dostal, J.; Capedri, S.; Aumento, F. (Dalhousie Univ., Halifax, Nova Scotia (Canada)). Earth Planet. Sci. Lett.; 26: No. 3, 345-352(Jul 1975).

The distribution of uranium in minerals and rocks of the ophiolitic sequences for the Northern Apennines (Italy) and the Hellenides (Greece) of the Tethyan mountain belt has been investigated by fission-track mapping. Wholerock U abundances, ranging from 11 to 74 ppb in ultramafic rocks, from 13 to 54 ppb in gabbroic rocks, from 73 to 281 ppb in basalts and from 279 to 900 ppb in spilites, partially reflect the post-crystallization history of the rocks. Among the fresh relics of primary rock-forming minerals, clinopyroxene has the highest U content. The estimated original U concentration of ultramafic rocks is about 1–10 ppb. These rocks do not appear to represent the primary undepleted mantle material. U distribution in the analyzed suites of opiolites is consistent with a model for alpine-type ophiolites, where harzburgites and lherzolites of the basal ultramafic zone represent the residuum after extraction of oceanic tholeitic magna. The segregated basaltic liquid either extruded rapidly as basalts or underwent magnetic differentiation in a quiet environment producing mineral accumulates as troctolites and gabbros. (auth)

**28112** LASER ISOTOPE SEPARATION OF DEUTERIUM. Marling, J. B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Chem. Phys. Lett.; 34: No. 1, 84-89(1 Jul 1975).

Highly selective isotope separation of deuterium has been demonstrated in laser-irradiated formaldehyde mixtures of $H_2CO$ and HDCO. Single-step deuterium enrichment factors of 14 were achieved by photodissociation into HD and CO, using HeCd laser light at 325.03 nm. Initial deuterium concentration ranged from 0.015 mole percent (natural abundance) to 5 mole percent. (auth)

## Isotopic Power Sources

*Refer also to abstract 28430.*

**28113** (GA-A-13426) RADIOISOTOPE SPACE POWER GENERATOR. Annual Report for the Period July 1, 1973–June 30, 1974. Elsner, N. B.; Chin, J. (General Atomic Co., San Diego, Calif. (USA)). 15 Jul 1975. Contract AT(04-3)-943. 89p. Dep. NTIS $7.50.

During the Isotec Technology Program in FY 1974, fabrication of the first ring converter segment was completed. In subsequent performance testing at Jet Propulsion Laboratories it demonstrated good agreement with the expected performance. The segment has accumulated over 7000 hours at a T/sub H/ of 450°C and the degradation rate over the last 5000 hours has been 0.1 percent. In the area of SiGe technology, continued compatibility tests between candidate insulation materials and SiGe, SiMo, and $Si_3N_4$ were conducted. $Si_3N_4$ in all cases continued to perform satisfactorily as a high temperature insulator. Low temperature $Si_3N_4$ coating development on SiGe thermocouples was performed by ion plating. While the ion plating process was successful in coating a whole couple, the $Si_3N_4$ deposited was silicon rich. Further process control of the stoichiometry of the material being deposited is required. The development of a more stable TAGS type alloy did not result in any alloys that had enhanced thermal stability; however, it may be possible to use one of the developed alloys in segmenting with TPM-217. (auth)

**28114** (LA-6034-MS) SAFETY TEST NO. S-6, LAUNCH PAD ABORT SEQUENTIAL TEST PHASE II: SOLID PROPELLANT FIRE. Snow, E. C. (Los Alamos Scientific Lab., N. Mex. (USA)). Aug 1975. Contract W-7405-eng-36. 20p. Dep. NTIS $4.00.

In preparation for the Lincoln Laboratory's LES 8/9 space mission, a series of tests was performed to evaluate the nuclear safety capability of the Multi-Hundred Watt (MHW) Radioisotope Thermoelectric Generator (RTG) to be used to supply power for the satellite. One such safety test is Test No. S-6, Launch Pad Abort Sequential Test. The objective of this test was to subject the RTG and its components to the sequential environments characteristic of a catastrophic launch pad accident to evaluate their capability to contain the $^{238}PuO_2$ fuel. This sequence of environments was to have consisted of the blast overpressure and fragments, followed by the fireball, low velocity impact on the launch pad, and solid propellant fire. The blast overpressure and fragments were subsequently eliminated from this sequence. The procedures and results of Phase II of Test S-6, Solid Propellant Fire are presented. In this phase of the test, a simulant Fuel Sphere Assembly (FSA) and a mockup of a damaged Heat Source Assembly (HSA) were subjected to single proximity solid propellant fires of approximately 10-min duration. Steel was introduced into both tests to simulate the effects of launch pad debris and the solid rocket motor (SRM) casing that might be present in the fire zone. (TFD)

**28115** (SAND-75-0053) SOLID PHASE WELDING OF TRANSITION MEMBERS FOR RADIOISOTOPE THERMOELECTRIC GENERATORS. Jellison, J. L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 49p. Dep. NTIS $4.00.

This investigation has demonstrated the feasibility of fabricating heat source-thermopile assemblies for radioisotope thermoelectric generators (RTG) by diffusion bonding techniques. The Au-Ni, Au-Cu, Au-Ag, and Au-Au systems were evaluated. With the 14 $MN/m^2$ (2000 psi) and 823°K (550°C) limitations imposed on the bonding process so as not to damage the thermopile, bonds of acceptable strengths were only obtained with the Au-Ni and Au-Cu systems. The Au-Ni system was selected for the transition members at the ends of the thermopile, because the Au-Cu system was not compatible for extended times at operating temperatures 673°K (approximately 400°C). Several solid-liquid interdiffusion (SLID) bonds were made using various combinations of gold or silver with germanium, indium, and tin-indium. Although SLID bonds could be made at low pressures (approximately 3.5 $MN/m^2$ or 500 psi), the resulting strengths were marginal at 723°K (450°C) for the RTG application. Procedures and tooling for fabrication of heat source-thermopile assemblies were developed, and two complete RTG assemblies were made by diffusion bonding. One of the assemblies was subjected to system shock and vibration tests and both thermopile and diffusion bonds survived without damage. (auth)

**28116** (SC-DR-66-2667) STRESS ANALYSIS OF THE SNAP-27 LUNAR FLIGHT CASK. Davis, R. E.; Dineen, R. L.; Berry, R. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1967. 30p. Dep. NTIS $4.75.

A stress analysis was performed on the beryllium lunar flight cask to determine if structural failure of the cask will occur during reentry after an Apollo mission abort. The analysis indicates that failure will not occur during reentry from an earth orbit abort; failure will probably occur after a lunar transfer orbit abort if the trajectory angle is near −6.4°, and will occur if the angle is near −30°. (auth)

**28117** (SC-RR-64-65) SAFETY ANALYSIS OF THE OPERATIONAL SNAP-9A SYSTEM. Buckalew, W.; Byrne, D.; Halsey, R. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1964. 81p. Dep. NTIS $7.25.

Declassified 20 Oct 1975.

The potential hazards of plutonium fuel release involved in operational application of the SNAP-9A generator in the Transit 5BN satellite are estimated. The discussion covers only those contingencies possible after the system is placed on the launch pad, including launch-pad aborts and re-entry from orbit. It analyzes the probable consequences of a release of plutonium fuel in various mediums. (auth)

**28118** (SC-TM-68-154) EXPERIMENTS ON SMALL PARTICLE ABLATION IN SIMULATED REENTRY: INTERIM REPORT. Marshall, B. W.; White, I. B. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1968. 21p. Dep. NTIS $4.25.

The ablation response of radioactive material when it is exposed to the reentry environment has a direct bearing on the severity of the hazard that may result. Plutonium dioxide microspheres ranging from 50 to 250 μm dia will be used as heat sources in certain SNAP space applications. It is necessary to determine the fate of such microspheres undergoing reentry from orbit or certain abort conditions. The studies discussed herein present results and tentative conclusions from experiments conducted in a 40-kW hyperthermal arc tunnel. Microspheres near 250 μm were supported on 160 μm dia stings and exposed for various periods of time — typically from 0.1 to 0.3 — to simulated reentry heating. The response of the microspheres was recorded on high speed film, with real time available from the film. In an effort to characterize the debris generated during ablation, sampling surfaces were placed downstream of the microspheres. The debris collected on the samplers was analyzed for size distribution and total quantity present. The results of the experiments are presented, and although complete reentry simulation cannot be accomplished in the laboratory, estimates of the effect of reentry on microspheres are made based on the results of these experiments. (auth)

**28119** THERMOELECTRIC GENERATOR, ESPECIALLY FOR CARDIAC PACEMAKERS. Purdy, D. L.; Magovern, G. J.; Smyth, N. P. D. (to Coratomic Inc.). German (FRG) Patent 2,433,637/A/. 30 Jan 1975. 39p. (In German).

The electronic arrangement and the whole construction of the cardiac pacemaker are described in detail as well as the method of incorporation in the human body. (GE)

# Radiation Sources

*Refer also to abstract 28087.*

## Design and Fabrication

**28120** RADIONUCLIDE EMITTERS FOR HIGH-TEMPERATURE MEASUREMENTS ON METALS USING POSITRON ANNIHILATION. Campbell, J. L.; Schulte, C. W. (Guelph Univ., Ontario (Canada). Dept. of Physics); Dieterly, D. K. (New England Nuclear Corp., Billerica, Mass. (USA)). Appl. Phys.; 6: No. 3, 327-334(Apr 1975).

The fabrication of $^{68}$Ge and $^{44}$Ti positron sources which can withstand temperatures up to 1,000°C is described. The sources are designed for use in the measurement of thermally-generated vacancy concentrations by the positron trapping technique. Measurements of positron lifetimes and Doppler-broadened annihilation photon lineshapes indicate that if suitable corrections are made the contribution of source matrix annihilations to experimental data can be reduced to less than 0.5% of the total annihilation events. (auth)

## Industrial Uses

*Refer also to abstracts 27549, 27579, 28030, 28187, and 28224–28226.*

**28121** (BMI-X-660) ASSESSMENT OF THE POTENTIALLY BENEFICIAL USES OF KRYPTON-85. Final Report, Task 64. Eggers, P. E.; Gawthrop, W. E. (Battelle Columbus Labs., Ohio (USA)). Jun 1975. Contract W-7405-eng-92. 98p. Dep. NTIS $6.00.

Results of a study aimed at assessing the potentially beneficial uses of $^{85}$Kr indicate that self-luminous light sources appear to be the foremost benefical use of $^{85}$Kr. Other assessed uses include heat sources for thermoelectric generators, heat sources for environmental control of submersibles, heat sources for thermodynamic energy cycles, polymerization processes, nondestructive testing, leak detection, biomedical applications, and liquid waste treatment. (TFD)

**28122** (PEL-244) APPLICATION OF IONIZING RADIATION TO THE SHELF LIFE EXTENSION OF MANGOES IN SOUTH AFRICA. Thomas, A. C. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Jan 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

The principal reason for considering the use of radiation was the control of the mango weevil which, inasmuch as it emerges from the pip, is impossible to control effectively by other methods. The ability of gamma radiation to penetrate matter makes it ideally suited to solve this problem. It has been established that a dose of 75 krad, in addition to completely deactivating the seed weevil, in combination with conventional hot-water dipping, inhibits only slightly less effectively than chemical fungicidal treatment, the two major fungal diseases which cause fruit losses. Simulated-shipping studies indicate that, as a result of the weevil and fungal control achieved by the combination treatment, sea shipment of the fruit to Europe seems feasible. In addition to the pest and disease control, irradiation of the fruit inhibits the physiological ripening process as shown by color development; this phenomenon has, however, not yet been quantified by a physical testing method. Organoleptic evaluations have demonstrated that treated fruit cannot be differentiated from nonirradiated fruit. Chemical evaluation of the fruit and of stored mango pulp has shown that no gross changes in chemical composition are produced by irradiation. (auth)

**28123** (RL-75-063) STACKED FILM BENDER FOR COLD NEUTRON BEAMS. Sutherland, J. C.; Wroe, H. (Science Research Council, Chilton (UK). Rutherford Lab.). Apr 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

A method of constructing a compact device for deflecting beams of cold neutrons ($\lambda \sim 10$ Å) through a few degrees, based on the guide tube principle, is given. A prototype bender for angles of 5° is described. The results of measurements of transmission efficiency are given and compared to the predictions of Monte Carlo computer calculations. (auth)

**28124** (STI/PUB-383) RADIOSTERILIZATION OF MEDICAL PRODUCTS, 1974. Proceedings of the Symposium on Ionizing Radiation for Sterilization of Medical Products and Biological Tissues Held at Bombay, India, December 9–13, 1974. (International Atomic Energy Agency, Vienna (Austria)). Jun 1975. 550p. (In Several Languages). (CONF-741217-). IAEA $33.00.

The purpose of the conference was to summarize and review critically the current information and experience on the practices of radiosterilization of medical products and biological tissues, including regulatory aspects. Individual abstracts were prepared for the 43 papers presented. (SFL)

*For abstracts of individual papers see: 27579, 28133–28167, 28189, and 28224–28227.*

**28125** (ZAED-BIBL.-05-15) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 05: Irradiation of Foods. Number 15. Delincee, H.; Ehlermann, D.; Gruenewald, T.; Harmuth-Hoene, A. E.; Muenzner, R. (comps.). (Zentralstelle fuer Atomkernenergie-Dokumentation, Leopoldshafen (F. R. Germany)). Jul 1975. 50p. Dep. NTIS (US Sales Only) $5.50.

The bibliography is based on original documents, mostly from the last two years, which are available at the library of the Bundesforschungsanstalt or from ZAED. In addition to the original titles, English translations of titles are presented. The index section consists of conferences, author, report numbers, subject, corporations and journals index. (TFD)

**28126** ACCURACY OF RADIOMETRIC HOLD-UP TIME MEASUREMENT. Geyer, H. (Technische Univ., Dresden). Isotopenpraxis; 11: No. 6, 201-207(Jun 1975). (In German).

Radiometric residence time measurement involves experimental influencing parameters causing erroneous registration of residence time distribution as well as erroneous values obtained on the basis of these distribution characteristics. In order to determine the accuracy of the characteristic values, the effect of the experimental influencing parameters (collimation of the detector, resolving time of the measuring equipment, half-life

of the radionuclide, and statistics of radioactive decay) exercised upon the statistical momenta and parameters are calculated analytically and described by means of the relative error. (auth)

**28127** APPARATUS FOR TREATING THE WALLS AND FLOOR OF THE PELVIC CAVITY WITH RADIATION. Clayton, R. S. US Patent 3,872,856. 25 Mar 1975. Filed date 24 Jul 1973. 10p.

An apparatus for treating carcinoma of the walls and floor of the pelvic cavity is described. An elongated tube has an inner end adapted to be placed in the pelvic cavity and an outer end adapted to extend through to the outside of the body. Radioactive material is placed at the inner end. An inner balloon above the radioactive material is inflated to hold a body of liquid shielding material such as mercury. A lower balloon portion beneath the inner balloon spaces areas to be treated such as the walls and floor of the pelvic cavity from the radioactive material. An upper balloon portion above the inner balloon keeps the intestines out of the pelvic cavity and away from the radioactive material. The apparatus is inserted into the pelvic cavity through an abdominal incision. When treating a woman for carcinoma in the walls and floor of the pelvic cavity the tube is moved through the vaginal passage from the inside outwardly. When treating a woman with a closed vaginal passage, as may result from surgery, or when treating a man, such as for carcinoma of the bladder, the tube will pass out of the body through a lower abdominal incision. Following treatment, all balloons are deflated so that the apparatus can be withdrawn through the vaginal passage or the lower abdominal incision, as the case may be. (auth)

**28128** TECHNIQUE FOR MEASURING INTERFACIAL CONCENTRATIONS OF SURFACTANTS AT THE OIL-WATER INTERFACE. Graham, D. E.; Chatergoon, L.; Phillips, M. C. (Unilever Research Lab., Welwyn, Eng.). J. Phys., E. (London); 8: No. 8, 696-699(Aug 1975).

A technique has been developed for directly measuring the amount of surfactant, which is suitably labelled with a $^{14}C$ atom, adsorbed at an oil-water interface. The technique entails using an oil-soluble, non-surface-active scintillant and a photomultiplier. The number of pulses detected is proportional to the $^{14}C$ surfactant concentration at the interface and after suitable calibration this can be transformed into the surface concentration. As an example, the technique is used to measure the adsorption isotherm for cetyl-1-$^{14}C$-trimethylammonium bromide at the toluene-water interface. The experimental surface concentrations are in close agreement with values obtained using the Gibbs' adsorption equation; this is the first time a direct test of this theory has been made for oil-water systems. (auth)

**28129** PROBLEMS ENCOUNTERED DURING THE DEVELOPMENT AND IMPLANTATION OF THE BAYLOR-RICE ORTHOTOPIC CARDIAC PROSTHESIS. Ross, J. N. Jr. (Baylor Coll. of Medicine, Houston, TX); Akers, W. W.; O'Bannon, W.; Spargo, W. J.; Serrato, M. A.; Fuqua, J. M. Jr.; Ruark, B. S.; Wieting, D. W.; Kennedy, J. H.; DeBakey, M. E. Trans., Am. Soc. Artif. Intern. Organs.; 18: 168-175; 179(1972).

The problems associated with the development of an artificial heart are enumerated. In a series of 24 calf implantations, several of the animals stood unassisted and reacted normally, but all eventually died with deteriorating circulatory and pulmonary systems. The problems caused by pump size and geometry represented the most important deterrents to long-term survival. A new prosthesis, though not yet tested in animals, is believed to minimize these problems. (auth)

**28130** CURRENT STUDIES WITH SIMULATED NUCLEAR-POWERED LEFT VENTRICULAR ASSIST DEVICES. Whalen, R. L.; Molokhia, F. A.; Jeffery, D. L.; Huffman, F. N.; Norman, J. C. (Harvard Medical School, Boston). Trans., Am. Soc. Artif. Intern. Organs.; 18: 156-161(1972).

Experiments with a simulated thermal system (STS) utilizing a Model VIII pump coupled to an implanted pneumatic-to-hydraulic converter (which simulates the size and weight of nuclear power sources) have served as pilot studies which led to implantations of a nuclear-fueled circulatory assist system. The results of the investigations, together with continuing studies of the radiobiologic effects of chronic intracorporeal radiation, offer encouraging evidence that the heat and radiation associated with nuclear-fueled circulatory support systems can be tolerated. (auth)

**28131** ISOTOPE METHOD FOR THE MEASUREMENT OF CREAMING. Wiechen, A.; Heine, K. (Bundesanstalt fuer Milchforschung, Kiel (F.R. Germany). Inst. fuer Physik). Kiel. Milchwirtsch. Forschungsber.; 26: No. 4, 319-324(1974). (In German).

A method is described which permits the course of creaming to be recorded continously and automatically by means of isotopes. Without affecting the colloidal system of milk, an isotope is added in hydrosoluble form and with only small amounts of carriers. A small detector sensitive to the respective radiation of the isotope is used to measure the decrease of counting rate on the head of the creaming cylinder, the decrease of rate being due to the effective recess of the radiation source and to the absorption of rays in the cream layer. The choice of the isotope, i.e., kind and energy of its radiation, and of the detector allows to adapt the sensitivity of the method to the rate of creaming. The method described appears to be superior to those techniques in which sedimentation balances are used; it could therefore supply useful information in research work on the process of creaming. (auth)

**28132** INDUSTRIAL APPLICATIONS OF RADIONUCLIDES. Waechter, K. H. (Mueller Barbieri A. G., Wettswil (Switzerland)). VDI (Ver. Dtsch. Ing.) Z.; 117: No. 7, 355-356(Apr 1975). (In German).

A survey of the applications of radioactive materials as tracer substances or as sealed radiation sources in German industry is presented. (GE)

**28133** RADIOCHEMICAL CHANGES IN POLYMERS USED FOR PACKAGING DRUGS. Ivanov, A. I.; Ponomarenko, S. I.; Koval'chuk, V. M.; Semenenko, E. I.; Myshkovskii, V. I. (All-Union Scientific Inst. for Medical Polymers, Moscow). pp 159-169 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Russian)

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Polymers are now widely used for packaging drugs sterilized with ionizing radiation. Sterilizing doses of radiation can cause changes in the structure and characteristics of polymers. Gas chromatography methods were used to study the composition of gaseous products formed during the radiation sterilization of low- and high-pressure polythene, polymethyl methacrylate (PMMA), PVC, and divinylstyrene and isoprenestyrene rubbers (DST-30 and IST-30), and it is shown that radiation sterilization causes complex radiochemical changes. Infra-red spectroscopy was used to investigate the effect of radiation sterilization on the structure of poly-4-methylpentene-1, low- and high-pressure polythene, PMMA, DST-30, IST-30 and PVC, and it is shown that gamma radiation causes radiochemical changes in polymers leading to the formation of ketones, aldehydes, acids, spirits, esters, unsaturated compounds, etc. Effective constants for the rate of formation of ketones and acids are determined and it is found that they are practically identical and independent of the thickness of the specimen within the range 30 to 150 mu m. It is shown that radiation sterilization causes insignificant changes to the aging mechanism of DST-30 in air and water. The investigation showed that the greatest resistance to the effects of radiation sterilization and aqueous solutions of insulin is offered by dimethyl siloxane rubber, among the rubbers, and polythene among the polyolefines. (auth)

**28134** DEVELOPMENT OF METHODS OF FORECASTING PROPERTIES OF POLYMER PACKAGING MATERIALS WHICH DO NOT CAUSE ANY CHANGES IN MEDICINAL PREPARATIONS DURING STERILIZATION. Krivonosov, A. I.; Postrigan, M. V. (All-Union Scientific Inst. for Medical Polymers, Moscow). pp 191-199 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Russian).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Results are presented of an investigation of the effect of gamma radiation on the properties of polymethyl methacrylates (molecular weight distribution, physicomechanical properties, resistance to the effects of aqueous media and physiological solution) in the form of copolymers of methyl methacrylate with methyl acrylate (MA) or butyl acrylate (BA) with the brand names Dacryl-4B, Dacryl-2M and Dacryl-4M (4 percent BA; 2 and 4 percent MA respectively) having a molecular weight of around $10^5$. For comparison, block polymethyl methacrylate with a molecular weight of $3 \times 10^6$ was used. The results of experiments on the aging of unirradiated and irradiated specimens in a heated store-room (t equals 10–20°C) and at high temperatures (90°C) are also given. It is shown that irradiation with doses of 2.5–20 Mrad leads to radiolysis of the above copolymers, accompanied by destructive processes. Evidence of this is an increase in the polydispersity of the materials and a reduction in their mean molecular weight. These changes impair their physicomechanical characteristics to some extent. Irradiation with a sterilizing dose of 2.5 Mrad reduces the strength indices by around 15 percent, which is quite acceptable for polymer products having high initial physicomechanical characteristics. Irradiation has practically no effect on the molecular and strength characteristics of Dacryl products

stored in a heated room, and the change in physicomechanical properties resulting from storage at high temperatures is practically the same for unirradiated and irradiated specimens. On the basis of these results the materials investigated can be recommended for the packaging of medicinal preparations. (auth)

**28135** PROSPECTS FOR RADIATION STERILIZATION OF MEDICAL PRODUCTS IN EGYPT. Roushdy, H. M. (National Centre for Radiation Technology, Cairo). pp 477-491 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The pharmaceutical industry in Egypt is continually expanding its activity and each year marks new accomplishments and additions which enable the companies to apply the most modern scientific means in the production of pharmaceutical preparations and consequently to improve their market potentials. The certainty of expansion and the possibility of increasing exports of sterilized medical products, particularly to Arab and African countries, indicate a need for a gamma-sterilization plant. This technology permits the introduction of the latest practices with regard to used disposables, thus greatly reducing the chances of cross-contamination which usually results in serious complications enhanced by local environmental conditions. This paper reviews the current state and future prospects for radiation sterilization of medical products and biological tissues in connection with other related industrial radiation processings. Moreover, the paper reviews the Egyptian scientific and technical experience with irradiation facilities and the parameters underlying the choice of Egypt's first industrial gamma and electron-beam irradiators designed for more than a single-purpose use, with hygienic measures taken to avoid biological contamination of sterilized medical packages throughout the sterilization process. In addition, the paper deals with the policy set up for establishing the Egyptian National Centre for Radiation Technology with a view to introducing irradiation techniques in the sterilization of medical products, and to improving the properties and increasing the competitiveness of Egyptian fabrics. Apart from medical sterilization, certain industrial processes have been mentioned to show how a multi-purpose irradiation facility may be utilized in a developing country to justify significantly the large investment required. (auth)

**28136** RADIOSTERILIZATION OF MEDICAL APPLIANCES USING A 5000-Ci COBALT-60 SOURCE. Molla, M. A. R.; Latif, M. A.; Haque, M. pp 493-502 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

A study has been made on the radiosensitivity of the pathogenic microorganisms in order to develop a method for the radiosterilization of medical products and appliances in Bangladesh. The tests were carried out on the following microorganisms: Pseudomonas pyocyaneus, Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae and Bacillus subtilis. Each microorganism was irradiated with uniform doses ranging from 0.0313 to 2.5 Mrad at suitable dose intervals using a nominal 5000-Ci $^{60}$Co source. A significant difference in the radiosensitivity was observed in different species of the microorganisms. For complete sterilization the doses varied between 0.25 to 1.75 Mrad depending on the microorganisms, the highest dose being required for the B. subtilis. To allow a safety factor a 2.5-Mrad dose has therefore been chosen for sterilization. This dose was then applied for sterilization of the intravenous transfusion sets prepared in the Institute of Public Health, Dacca. Over 100,000 transfusion sets have so far been radiosterilized and successfully used in different hospitals. The radiation dosimetry of the $^{60}$Co source was made by a Victoreen R-meter and verified by the Fricke chemical dosimetry method. (auth)

**28137** RADIATION-STERILIZATION PRACTICES IN KOREA. Rhee, K. S. (Korea Atomic Energy Research Inst., Seoul). pp 503-510 of Radiosterilization of Medical Products, 1974. Vienna, International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The need for cold sterilization to sterilize medical devices and supplies has been emphasized. It has recently become known that a Radiation Processing Demonstration Facility is one of the most effective tools for such sterilizing methods. Since January 1972 the Korea Atomic Energy Research Institute has planned building a Radiation Processing Demonstration Facility as a co-project of the Korea Atomic Energy Research Institute, the United Nations Development Programme and the International Atomic Energy Agency. It will be finished in June 1975. To ensure the effective use of this Facility after being set up, the Korea Atomic Energy Research Institute is now carrying out various sterilization experiments and training technologists. (auth)

**28138** TESTS OF THE VALIDITY OF A MODEL RELATING FREQUENCY OF CONTAMINATED ITEMS AND INCREASING RADIATION DOSE. Tallentire, A.; Khan, A. A. (Univ. of Manchester, Eng.). pp 3-14 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The $^{60}$Co radiation response of Bacillus pumilus E601 spores has been characterized when present in a laboratory test system. The suitability of test vessels to act as both containers for irradiation and culture vessels in sterility testing has been checked. Tests have been done with these spores to verify assumptions basic to the general model described in a previous paper. First measurements indicate that the model holds with this laboratory test system. (auth)

**28139** PRE-STERILIZATION CONTAMINATION OF DISPOSABLE MEDICAL PRODUCTS AND THE CHOICE OF MINIMUM STERILIZATION DOSE. Horakova, V.; Buriankova, E. (SVUT Center for Research and Application of Ionizing Radiation, Brno). pp 15-24 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The bacterial contamination was assessed randomly taken samples of blood-transfusion devices, donor sets, intra-uterine contraceptive devices and inserters, surgical gloves and dressing material prior to sterilization. The quantitative and qualitative efficiency of six nutrient media was compared. The best results were obtained with the enriched "Universal" medium. It was confirmed that the contamination of plastic products was low compared with dressing material. Most frequently, Gram-positive aerobic spore-forming rods and Gram-positive cocci were found on non-sterile medical disposable products. A method was tested to obtain a general informative picture of the resistance of bacteria on products. The methods used for choosing the dose for radiation sterilization of medical products are discussed. (auth)

**28140** SYNERGISTIC EFFECTS OF HEAT AND IRRADIATION TREATMENT (THERMORADIATION) IN THE STERILIZATION OF MEDICAL PRODUCTS. Trauth, C. A. Jr.; Sivinski, H. D. (Sandia Labs., Albuquerque, NM). pp 25-44 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383, CONF-741217-.

This paper describes a generic class of sterilization processes in which properly chosen combinations of radiation and heat synergistically inactivate many bacteria and viruses. Treatments with optimal combinations are shown to offer the possibility of using lower total doses and lower temperatures than would be required separately for sterilization. This results from easier elimination of heat-labile, radioresistant organisms and radiolabile, heat-resistant organisms, and from synergistic inactivation of organisms which are both radioresistant and heat resistant. These processes depend upon temperature, dose-rate, and time in fairly complex ways; therefore, an analytical framework in which they can be defined is also presented. (auth)

**28141** FACILITY CALIBRATION, THE COMMISSIONING OF A PROCESS, AND ROUTINE MONITORING PRACTICES. Chadwick, K. H. (Association EURATOM-ITAL, Wageningen, Netherlands). pp 69-81 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Radiation dosimetry provides an independent control of the radiation sterilization process. The various dosimetric measurements which should be carried out in calibrating a facility and commissioning a process are discussed. Some attention is given to batch-operated plants, the calibration of a dosimetry system and accuracy and precision in use. One or two dosimetry systems which are being developed for megarad doses are briefly discussed. (auth)

**28142** USE OF CERIC SULPHATE AND PERSPEX DOSIMETERS FOR THE CALIBRATION OF IRRADIATION FACILITIES.

Chu, R. D. H.; Antoniades, M. T. (Atomic Energy of Canada Ltd., Ottawa). pp 83-99 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The conditions encountered during the calibration of a $^{60}$Co radiation sterilization plant may differ considerably from the conditions under which the dosimetry systems are calibrated. Variations in the dose-rate, temperature, and energy spectrum may affect the dosimeter response. The effects of these parameters on ceric sulphate and Perspex dosimeters were studied and it was concluded that the ceric sulphate and Perspex-type Red 4034 dosimetry systems are both suitable for irradiator calibration provided that adequate precautions are taken in their use. (auth)

**28143** INDUSTRIAL AND DOSIMETRIC ASPECTS OF RADIATION STERILIZATION IN AUSTRALIA. Wills, P. A.; Clouston, J. G.; Matthews, R. W. (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). pp 101-112 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of Medical Products and Biological Tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Radiation sterilization has been practised in Australia since 1960. Medical goods, pharmaceuticals, lyophilized reagents used for pharmaceuticals, and biological tissues (fascia lata in particular) are sterilized at three $^{60}$Co plants and at a small facility at the Australian Atomic Energy Commission's Research Establishment. All processing is carried out at 2.5 Mrad in accordance with the Australian Code of Good Manufacturing Practice for Therapeutic Goods. However, the Code does not preclude the use of lower doses in special circumstances. A ceric-cerous megarad dosimeter has been developed. It is used for calibration of plant and routine dosimetry. Dosimeters are measured potentiometrically using a direct reading meter. (auth)

**28144** "TAC" FILM, A PLASTIC DOSIMETER FOR PRACTICAL MEASUREMENT OF IRRADIATION DOSES RECEIVED DURING STERILIZATION. Puig, J. R. (CEN de Saclay, Gif-sur-Yvette, France); Laizier, J.; Sundardi, F. pp 113-134 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In French)

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The characteristics of a dosimetric film ("TAC") recently placed on the market were investigated. Both for cobalt-60 gamma rays and for 0.3-6 MeV electrons, the absorption varies linearly with dose in the range 1-10 Mrad. The dose-rate effect is weak with gamma rays and nil with electrons. The response is stable in time and is not modified by heating for one hour at 80°C. This film therefore appears well suited for monitoring the radiosterilization process on an industrial scale, and also for many practical measurements, of which various examples are given. (auth)

**28145** MONITORING OF THE RADIATION STERILIZATION PROCESS. Khrushchev, V. G.; Balitskii, V. A.; Grinev, M. P.; Mikhailov, L. M. (Inst. of Biophysics of the USSR, Moscow). pp 137-144 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Russian)

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

A system for monitoring the radiation sterilization of medical products is described, which consists of (1) measuring the basic radiation characteristics of a facility at the time of commissioning and after overhauls, (2) periodic checking of the basic parameters of the radiation fields, and (3) direct monitoring of the sterilizing dose. The dosimetric systems and methods used to perform these measurements at each stage are examined. The operation of the proposed system is illustrated by specific examples, namely the calibration of radiation fields during commissioning and routine operation of two facilities-a $^{60}$Co facility with an activity of 126 kCi and a facility using a linear electron accelerator with a rated energy of 8 MeV and beam power of 5 kW. (auth)

**28146** POLYETHYLENE PLASTICS AS CONTAINERS FOR WATER FOR INJECTION AS MATERIAL FOR DISPOSABLE MEDICAL DEVICES STERILIZED BY RADIATION. Hilmy, N.; Sadjirun, S. (National Atomic Energy Agency, Jakarta, Indonesia). pp 145-157 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Investigations on polyethylene plastic manufactured in Indonesia have been carried out in order to study the possibilities of using it for containers for pharmaceutical products and as material for medical devices sterilized by irradiation. The investigations involved biological experiments on systemic toxicity, skin irritation, pyrogen, haemolysis, and contamination prior to sterilization; and physico-chemical experiments such as the determination of hydrogen peroxide, oxidizable matter, the absorption of u.v. spectra, non-volatile residue, determination of pH and of heavy metals, and weight loss during storage. Biologically the results of these experiments could be accepted, but physico-chemically no conclusion could be reached because of the non-existence of maximum limits of hydrogen peroxide, oxygen, and also because of the possible problems of radicals in water for injection. (auth)

**28147** CHEMICAL AND BIOLOGICAL EFFECTS OF RADIATION STERILIZATION OF MEDICAL PRODUCTS. Gupta, B. L. (Bhabha Atomic Research Centre, Trombay, India). pp 179-190 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Radiation is extensively used for the sterilization of plastic materials, pharmaceuticals and biological tissue grafts. The pharmaceuticals may be solid, liquid, or suspension in a liquid or a solution. Cobalt-60 gamma radiation, generally used for sterilization, primarily interacts with these materials through the Compton process. The resulting damage may be direct or indirect. In aqueous systems the primary species produced compete for interaction among themselves and the dissolved solutes. The nature, the G-values and the reactions of the primary species very much depend on the pH of the solution. The important chemical changes in plastic materials are gas liberation, change in concentration of double bonds, cross-linking, degradation and oxidation. These chemical changes lead to some physical changes like crystallinity, specific conductivity and permeability. The reactions in biological systems are very complex and are influenced by the presence or absence of water and oxygen. Water produces indirect damage and the radiation effect is generally more in the presence of oxygen. Most microorganisms are relatively radioresistant. Various tissues of an animal differ in their response to radiation. Catgut is not stable to irradiation. Lyophilized human serum is stable to irradiation whereas, when irradiated in aqueous solutions, several changes are observed. Generally, pharmaceuticals are considerably more stable in the dry solid state to ionizing radiations than in aqueous solutions or in any other form of molecular aggregation. (auth)

**28148** COMPARISON OF SOME PROPERTIES OF TISSUE GRAFTS STERILIZED BY COLD SHOCK AND IONIZING RADIATION. Klen, R.; Pacal, J. (Faculty Hospital, Hradec Kralove, Czech.). pp 203-214 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The paper compares some essential properties of grafts prepared for clinical grafting by a common procedure (sterilizing by cold shock, preservation by freeze-drying) with those experimental grafts sterilized by 2.5 Mrad gamma rays from a $^{60}$Co source before or after preservation by freeze-drying. In rib-bone grafts, the course of re-hydration and the mechanical properties were tested. The results indicate that radiation sterilization is not a suitable method for bone grafts. In rib-cartilage grafts, the rates of weight and volume increasing during re-hydration were examined and the differences compared. The content of potassium and mucoproteins released into the eluate was measured during re-hydration in order to obtain some insight into the type of radiation damage. Sterilization by irradiation was again found unsuitable. In skin, chorion and fascia grafts, the permeability was evaluated. For skin and fascia grafts, the prospect of using ionizing radiation for sterilization purposes seems promising. More data are still needed to reach a definite conclusion. (auth)

**28149** EFFECTS OF STERILIZING DOSES OF IONIZING RADIATION ON THE MECHANICAL PROPERTIES OF VARIOUS CONNECTIVE TISSUE ALLOGRAFTS. Triantafyllou, N.; Karatzas, P. (Nuclear Research Center Democritos, Athens). pp 215-223 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Ionizing radiations are being utilized to sterilize hard and soft connective tissues. With the sterilizing dose of 2.5 Mrad, deterioration is found in the mechanical properties of the tissues. For bone the deterioration is mainly in the organic collagen matrix. It has been observed that the freeze-drying procedures utilized as a preliminary procedure before radiation treatment contribute significantly to the overall mechanical deterioration, and are further accentuated by the radiation treatment. Experiments with dura mater and pericardium show that not only collagen, but the fibroelastic structure is sensitive towards the sequence of treatments usually accorded to radiation-sterilized transplant materials. (auth)

**28150** ORGANIZATION AND IMMUNOLOGICAL QUALITIES OF LYOPHILIZED AND RADIOSTERILIZED EXTRASYNOVIAL DOG-TENDON PREPARATIONS. Feher, I.; Pellet, S. Jr.; Unger, E.; Petranyi, G. (Frederic Joliot-Curie National Research Inst. for Radiobiology and Radiohygiene, Budapest). pp 225-237 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

In experiments the organization and immunological properties of lyophilized radiosterilized dog-tendon preparations after implantation were studied. According to the experimental results the lyophilized dog-tendon preparations seem to be of the same value for surgical use as the fresh tendon. The preparations can be easily stored and transported and if implanted they are quickly rebuilt to living tendon tissue. According to the pilot experiments the method of preparation does not influence the immunological qualities of the human tendon; this preparation does not behave as antigen. (auth)

**28151** DIFFERENT METHODS OF STERILIZATION OF MEDICAL PRODUCTS. Dawson, J. O. (Ethicon Ltd., Edinburgh). pp 265-268 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The classical methods of sterilization - wet chemical, steam under pressure, dry heat, and gaseous methods, depend on time of exposure, temperature and moisture content. They are mainly batch processes, and scaling up leads to difficulties. In a properly designed irradiation facility the only variables are time of exposure and density of product. Subject to initial design the capacity can be increased. The process is applied to the final sealed container, no aseptic handling being required. (auth)

**28152** APPRAISAL OF THE ADVANTAGES AND DISADVANTAGES OF GAMMA, ELECTRON, AND X-RAY RADIATION STERILIZATION. Morganstern, K. H. (Radiation Dynamics, Inc., Westbury, NY). pp 269-288 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Since radiation sterilization was first introduced as a viable technique for the sterilization of medical products, there has been considerable discussion of the relative merits of gamma rays versus accelerator-produced electrons. Although the early sterilization work at Ethicon started with an electron device, the problems associated with these early generation electron devices convinced the researchers to switch to $^{60}$Co gamma sources as their radiation choice. Over the intervening period of approximately two decades, considerable changes have taken place with respect to both $^{60}$Co facilities and sources, and electron accelerators. The status of both is reviewed and up-dated. The changes in source cost, construction techniques and production flow for $^{60}$Co sterilization plants are examined. The advantages of $^{60}$Co as it relates to simplicity and ease of maintenance are discussed as well as the disadvantages of long dwell time and facility complication. Typical plant efficiencies for both continuous flow and batch gamma plants are described, and the fact that radiation utilization (efficiency) factors with gamma facilities are still relatively low and have not changed radically over the period is reviewed. Finally, the economics of gamma-ray sterilization are examined for typical medical products. With regard to electron accelerators, both linacs and d.c. generators have undergone considerable changes in both power levels and degree of process reliability. These improvements are described and the apparent acceptance afforded electron accelerators as production tools by industries other than medical disposables. In addition, the relationship of medical product packaging, product flow and point of sterilization in the production flow and the type of electron device most suitable are discussed. Further, the advantages of higher-powered electron accelerators (up to 150 kW) and their ability to generate x-ray fluxes comparable with those for $^{60}$Co plaques make it necessary to consider this possibility as well, in attempting to arrive at an optimum radiation sterilization facility design. The economics of medical product sterilization with electrons used directly or with secondary-produced x-rays are examined and compared with gamma-ray economics. (auth)

**28153** TECHNOLOGY OF RADIOSTERILIZATION INSTALLATIONS: SOME ASPECTS CONCERNING THE DEVELOPING COUNTRIES. Eymery, R. (CEN, Grenoble, France). pp 289-303 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In French).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

After briefly summarizing the conditions of interaction of accelerated electrons and gamma rays with matter, the most favorable geometries for irradiating medical material is examined. Technical devices for irradiation are then examined, as is the mode of operation of the installation, which can be continuous or batch. It appears that only a detailed study of the present and future needs of the user can permit definition of a satisfactory type of conveyor and mode of operation. The possibility of using an accelerator is envisaged. The principal criteria that should be applied by the developing countries are, in order of importance: safety of the installation, its reliability, uniformity of the dose obtained, and, finally, versatility and yield. (auth)

**28154** RADIATION DOSIMETRY PROBLEMS WHEN STERILIZING MEDICAL PRODUCTS IN GAMMA-IRRADIATION PLANTS. Krishnamurthy, K. (Bhabha Atomic Research Centre, Trombay, India). pp 305-322 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

All pertinent aspects of dosimetry in commercial gamma sterilization plants with reference to those arising out of design and prevailing conditions of operation of the plant are discussed. A brief description of ISOMED, India's first large-scale radiation plant for sterilization of medical products and the results of dosimetry obtained therein are given in order to provide a realistic basis for focusing the attention on various aspects discussed. (auth)

**28155** PLANNING OF GAMMA-FIELDS: FORMING AND CHECKING DOSE-RATE HOMOGENEITY IN IRRADIATION FACILITIES. Stenger, V.; Foeldiak, G.; Horvath, Z.; Naszodi, L. (Inst. of Isotopes, Budapest). pp 323-329 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The optimal geometry of the sources of an 80,000-Ci $^{60}$Co irradiation facility was calculated. The array of the sources is suitable for fundamental research and pilot-plant radiosterilization simultaneously. A method was developed to compensate the inhomogeneity of the dose-rate field; it is no worse than that of the continuous large-scale facilities. In five years the activity of the sources decreased by about half; therefore, this recharge became inevitable. Experience proved that with the new source geometry optimalized by calculations a dose-rate of 1.2 ± 10% became available within the packages. (auth)

**28156** LOW-COST IRRADIATION FACILITY FOR PILOT-SCALE PROCESS IRRADIATION STUDIES. Krishnamurthy, K.; Aggarwal, K. S. (Bhabha Atomic Research Centre, Trombay, India). pp 331-338 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

A few salient aspects of a low-cost irradiation facility designed and constructed by the Isotope Division of BARC, India, are described. A batch-type shuffle-dwell conveyor system, which has been developed to optimize the dose conformity and irradiation efficiency for the medical products, is briefly detailed. Experimental observations of parameters such as radiation heating in the storage container, variation of irradiation efficiency with products of different types, are also indicated. (auth)

**28157** INDUSTRIAL FACILITIES FOR THE RADIATION STERILIZATION OF MEDICAL PRODUCTS. Osipov, V. B.;

Mamikonyan, S. V.; Stepanov, G. D. (All-Union Scientific Research Inst. for Radiation Techniques, Moscow). pp 341-350 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Russian)

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The reasons for setting up industrial radiation facilities for sterilizing medical products in the Soviet Union are explained, and the principle of operation, the design features and the main technical and operating characteristics of these facilities, which use the LUE-8/5B electron accelerator or $^{60}Co$ as their radiation source are described. (auth)

**28158** RADIATION STERILIZATION OF RADIOPHARMACEUTICAL PREPARATIONS. Bochkarev, V. V.; Kharlamov, V. T.; Pikaev, A. K.; Shubnyakova, L. P.; Potapova, Z. M.; Pavlov, E. P. (Inst. of Biophysics of the USSR, Moscow). pp 365-378 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Russian)

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The majority of radiopharmaceuticals are solutions for injection and have to be made available in sterile form. However, some of them do not withstand thermal sterilization, and autoclaving is technologically impracticable for mass production owing to the high level of radiation from the solutions produced. In view of this, radiation sterilization may well be the most effective method; it should be possible to sterilize radiopharmaceuticals in the package, by remote control, and in a continuous process. Our investigations show that gamma irradiation of a number of radiopharmaceutical preparations labelled with $^{131}I$ results in their radiochemical decomposition, manifested by a drop in pH, reduction in concentration of the basic substance and the formation of labelled and non-radioactive radiolysis products. The inclusion of certain acceptors of radicals formed during the radiolysis of water in some cases prevents these preparations from decomposing and enables them to retain the basic properties called for by pharmacopoeial specifications. At the same time it has been established that, given the bactericidal characteristics of certain radiopharmaceutical preparations, the relatively low microbe contamination and the high radiosensitivity of the microflora present in radiopharmaceutical preparations produced in the USSR, they can be reliably sterilized with a dose of around 1 Mrad. On the basis of the results obtained the radiation method can be considered promising for the sterilization of radiopharmaceutical preparations. (auth)

**28159** FEASIBILITY STUDIES ON RADIATION STERILIZATION OF SOME PHARMACEUTICAL PRODUCTS. Gopal, N. G. S.; Rajagopalan, S.; Sharma, G. (Bhabha Atomic Research Centre, Trombay, India). pp 387-402 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The paper deals with some studies carried out to evaluate the feasibility of radiation sterilization or treatment of some medical products and pharmaceuticals of immediate importance to their respective industries. The products include penicillin G sodium, ampicillin sodium, tetracyclin hydrochloride ointment, hydrocortisone acetate and its ointment, aqueous sodium chloride solutions (0.9 and 20%), fluorescein sodium strips, urea, ethylmorphine hydrochloride, aqueous solution of chlorobutanol and one of its commercial preparations, phenylmercuric nitrate and its aqueous solutions, aqueous solutions of methyl and propyl paraben, lactose, gum karaya, absorbent cotton and poly-(vinyl chloride) based medical products. The irradiated products have been examined for pharmacopoeial specifications wherever available. In general the products have been examined for changes in color, pH, ultra-violet and infra-red absorption spectra. Thin-layer chromatographic analyses have been carried out to establish the purity of some of the irradiated products. The feasibility or otherwise of radiation sterilization or treatment of the various products from the physicochemical and microbiological (pharmacological) clinical considerations is also described. (auth)

**28160** SAFETY AND CLINICAL EFFICACY OF SOME RADIATION-STERILIZED MEDICAL PRODUCTS AND PHARMACEUTICALS. Kulkarni, R. D. (Grant Medical Coll., Bombay); Gopal, N. G. S. pp 403-408 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Medical products and pharmaceuticals must conform to certain minimum physico-chemical microbiological and biological requirements. The biological requirements comprise principally testing for toxicity, safety, and pyrogens. Besides the above-mentioned criteria, there are two other important characteristics, viz. clinical efficacy and tolerance in animal and/or human beings. These latter requirements, expected from the final product released for general human use, are not carried out routinely. In the present-day pharmaceutical and medical technology, numerous new products are appearing, many of them requiring radiation sterilization as they are not stable towards the other conventional methods of sterilization. While the post-irradiation physico-chemical changes in a product may not be significant, the bio-availability or biological activity of the product may be affected to a more significant extent. Some evidence of this has recently been reported. Hence, it is desirable to carry out studies on safety as well as clinical efficacy on irradiated products. This paper describes some studies on plastic-based medical products, a pharmaceutical raw material, a typical infusion fluid such as normal saline, antibiotics and their ointments. (auth)

**28161** FACTORS INVOLVED IN PLANNING RADIATION-STERILIZATION PRACTICES AND TECHNOLOGY IN THE DEVELOPING COUNTRIES, AND THE AGENCY'S PROMOTIONAL ROLE. Jukherjee, R. N.; Yuan, H. C. (International Atomic Energy Agency, Vienna). pp 415-430 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The application of ionizing radiation for sterilizing ready-to-use medical supplies, sutures and grafts provides a broad scope for the up-grading of public health care and family planning programmes in the developing countries. Sterile ready-to-use medical supplies become particularly important for improving the standard of those services given through the improvised camp-hospitals and mobile medical units for the remote areas of such countries, if needed. The practices generated in the technologically advanced countries will form the basis of the planning, but the necessary adjustments should be made in their implementation to suit best the local conditions and needs and to promote utilization of local raw materials. Necessary research and development and an effective infrastructure should be emphasized. Plastic materials are among the major pollutants of the environment. Timely parallel practical steps need be adopted and an action programme planned to preserve the quality of the human environment. (auth)

**28162** REVIEW OF THE STERILIZATION OF SURGICAL SUTURES. Dawson, J. O. (Ethicon Ltd., Edinburgh). pp 431-435 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The sterilization of surgical sutures by ionizing radiation was the first commercial application of this process to the sterilizing of medical products. The history of the sterilization of sutures goes back 100 years to Lord Lister and the developments parallel those of other medical products. The evolution of such products is the result of ever improving technology in microbiological techniques, evaluation of physical properties. (auth)

**28163** CURRENT STATE OF RADIATION STERILIZATION OF MEDICAL PRODUCTS IN INDIA: PROBLEMS AND SPECIAL ADVANTAGES IN DEVELOPING COUNTRIES. Iya, V. K.; Deshpande, R. G.; Krishnamurthy, K.; Rao, M. V. (Bhabha Atomic Research Centre, Trombay, India). pp 437-446 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Radiation sterilization is now firmly established as an industrial process for sterilizing a wide variety of medical products. The introduction of this technique has enabled the development of a number of inexpensive single-use products, offering a high degree of quality assurance for use in medical and surgical procedures. The need for introducing this technique in India was felt in the sixties. The developments leading to setting up ISOMED, a radiation plant for the sterilization of medical products at Trombay, and the specialized services offered to manufacturers of medical products, are described. The legal aspects of radiation sterilization in India are briefly discussed. Finally, the benefits of this technology to developing countries and some of the problems encountered in introducing it are also discussed. (auth)

**28164** RADIATION STERILIZATION IN ISRAEL: PAST, PRESENT, AND FUTURE. Aronson, M.; Eisenberg, E.; Lapidot, M. (Tel Aviv Univ., Israel). pp 447-458 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The last decade has seen a considerable effort to introduce commercial radiation sterilization into Israel. Despite a highly developed and modern medical care system, this effort has been an uphill struggle. However, with the help of detailed and frequently updated economic feasibility studies, and very close co-operation with industry and medical care authorities, considerable progress has been acheived in the last few years. Recent development and promotional efforts should result in quicker implementation of additional products and processes aimed at doubling the radiation-sterilized products volume every two or three years for another decade. (auth)

**28165** PROPOSED PHILIPPINE RADIATION-STERILIZATION PLANT, AND A SURVEY OF MARKET POTENTIAL. Singson, C. C.; Ibe, L. D. (Philippine Atomic Energy Commission, Manila). pp 459-465 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

A study to assess the market potential of radiation sterilization in the Philippines was conducted. A market survey conducted with the technical assistance of an IAEA expert from India shows that most of the pharmaceutical industries engaged in the manufacture of medical products unanimously agree that there is an urgent need for a centralized radiation-sterilization plant to meet the demands of sterilization of most of their products and packaging materials. The authorities of the government and some of the private hospitals surveyed are also very keen for the establishment of a sterilization facility since most modern medical products and devices are made of heat-sensitive thermoplastics which cannot be heat or steam sterilized. Availability of sterile products will help prevent cross-infection and ultimately help improve the public health standards of the population. The scope of the utilization of a radiation-sterilization facility in Diliman Quezon City is also discussed. (auth)

**28166** PROGRESS OF RADIOSTERILIZATION IN THE ARGENTINE REPUBLIC. Mariano, E. E.; Mugliaroli, H. A. (Comision Nacional de Energia Atomica, Buenos Aires). pp 467-476 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Spanish).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The technological and economic advantages of radiation as a means of sterilization have led to a steady expansion of its use. With the significant increase in the radiosterilization of medical products, the health authorities have established standards for the use of radiation for that purpose. These standards will be incorporated in the next edition of the Argentine Pharmacopoeia. In general, Argentine legislation in this area is based on the IAEA's Code of Practice for Radiosterilization of Medical Products. The microbiology services of Argentina's National Atomic Energy Commission (CNEA) determine the number of viable microorganisms in each product and package the product before irradiation. The controls are carried out on random samples. At the same time, the chemistry laboratories carry out quality controls on new products which have received sterilizing doses of gamma radiation. The gas sterilization methods employed most widely in the industrial manufacture of thermolabile products involve the use of ethylene oxide or formaldehyde. The cost of this process is influenced considerably by the fact that Argentina has to import ethylene oxide. The low penetrating power of formaldehyde means that the package containing the product must still be open at the time of sterilization if an adequate safety margin is to be ensured; consequently, one needs sterile installations for the post-irradiation sealing of packages. The capital and operating costs of such installations are high. A comparison has been made of the costs of sterilizing 11000 $m^3$ of a product with a density of 0.1 $g/cm^3$ and the following relative values obtained: ethylene oxide, 399.2; formaldehyde, 947.5; gamma radiation, 166.0. Studies of the effects of sterilizing doses on certain pharmaceutical products have demonstrated that the radiosterilization of some drugs is possible. The CNEA has designed an installation for the radiosterilization of medical products; the installation would have a 500,000-Ci cobalt-60 source and an annual capacity of some 11,000 $m^3$. (auth)

**28167** RECOMMENDATIONS FOR THE RADIATION STERILIZATION OF MEDICAL PRODUCTS. (International Atomic Energy Agency, Vienna). pp 513-523 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

In 1967 the IAEA, in collaboration with the WHO, prepared a Recommended Code of Practice for the Radiosterilization of Medical Products to serve as a guide for drawing up national standards and rules regulating radiosterilization practices in Member States. The need for revising this code has been evident as the result of recent operating experience with radiosterilization facilities. Revisions proposed by a group of 10 international experts are presented and include recommendations for the manufacture of medical products; product packaging; radiosterilization facility commissioning, process control and quality control; and the operation of gamma-irradiation plants and electron irradiation plants. (LCL)

# LIFE SCIENCES

## Radiation Effects on Biochemicals

*Refer also to abstracts 28158 and 28275.*

**28168** SECONDARY FREE RADICAL REACTIONS IN IRRADIATED FROZEN AQUEOUS SOLUTIONS OF AMINO ACIDS AND PEPTIDES. Usatyi, A. F.; Panin, V. I. Biophysics (USSR) (Engl. Transl.); 18: No. 3, 460–469(1973).

Translated from Biofizika; 18: No. 3, 439–446(1973).

The EPR method was used to study the secondary free radical reactions occurring in electron irradiated frozen aqueous solutions of mixture of amino acids (1 M) and peptides (0 • 1 M). The radicals $R_A$ formed as a result of deamination of the amino acids enter into intermolecular reactions of separation of a hydrogen atom from the amino acid residues of the adjacent peptide molecules (170–230°K). Change in the localization of the free valency is accompanied by the corresponding transformation of the EPR spectra. The end spectrum is due to the radical $\sim NH-\dot{C}R-CO\sim$, R = H, $CH_3$ and so on. Study of the kinetics of the reactions revealed two stages of the process. The activation energy of the fast stage does not depend on the concentration of the reagents but is determined by their structure. The slow stage is a diffusion-controllable process. In the n.m.r.-$H^1$ spectra of the solutions of irradiated peptide, signals of the fragment $R_A-H$ are found–non radical products of secondary reactions. (auth)

**28169** KINETICS OF CHANGES IN MOUSE OXYHAEMOGLOBIN ON ULTRAVIOLET IRRADIATION. Artyukhov, V. G.; Shmelev, V. P. (Voronezh State Univ., USSR). Biophysics (USSR) (Engl. Transl.); 18: No. 3, 522–526(1973).

Translated from Biofizika; 18: No. 3, 497–500(1973).

The quantitative patterns of photo-oxidation of mouse hemoglobin on exposure to the total flux of ultraviolet reduction are elucidated. It has been established that the process of oxidation of the molecules of oxyhaemoglobin in an aqueous medium proceeds with a relatively high quantum yield (0.164). The authors have also investigated the kinetics of change in the absorption of solutions of oxyhaemoglobin exposed to ultraviolet irradiation at 20 to 50°C. It is shown that the influence of temperature during ultraviolet irradiation is manifest in increase in the rate of photo-oxidation of the oxyhaemoglobin molecules. Rise in the radiation dose leads to a substantial fall in the activation energy of this photo-process. (auth)

**28170** INDUCTION OF PHENYLALANINE AMMONIA LYASE (PAL) IN GAMMA-IRRADIATED POTATOES. Pendharkar, M. B.; Nair, P. M. (Bhabha Atomic Research Center, Bombay). Radiat. Bot.; 15: No. 2, 191–197(Jun 1975).

The exposure of potatoes to gamma rays (10 krad) caused on induction of phenylalanine ammonia lyase (PAL) in the tubers. The induced activity was localized essentially in cortex tissue, mainly concentrated around the bud region, whereas in parenchymatous tissue no induction was observed. The enhancement in PAL activity in buds was observed to be dependent on dose of irradiation and the duration of storage thereafter. The tubers exposed to a 10 krad dose showed maximal activation on storage at ambient conditions with 20 fold activity observed within three hours after irradiation. On further storage, the activity declined and reached a constant level within a period of one week. The increase in PAL activity was partly due to activation of the inactive form of the enzyme (30 to 40%) and partly due to de novo synthesis of protein (60 to 70%). (auth)

**28171** PROPERTIES OF THE ULTRAVIOLET-LIGHT-MEDIATED BINDING OF BOVINE SERUM ALBUMIN TO DNA. Braun, A.; Merrick, B. (Brandeis Univ., Waltham, MA). Photochem. Photobiol.; 21: No. 4, 243–247(Apr 1975).

The binding of DNA to protein mediated by uv (254 nm) radiation has been investigated using binding of the complex to Millipore membrane filters as an assay technique. The reaction proceeded through an activated protein intermediate which then reacted with the DNA. The activated protein had a half-life of about 75 min at 0°C and about 18 min at 37°C. Short wavelengths were more efficient in forming the complex than wavelengths in the 250 to 280 nm range. N-ethyl maleimide treatment of protein before irradiation markedly inhibited the reaction. (auth)

**28172** DNA REPAIR OF ULTRAVIOLET-IRRADIATED BACTERIOPHAGE T4. Frieberg, E. C. (Stanford Univ., CA). Photochem. Photobiol.; 21: No. 4, 277–289(Apr 1975).

A review of studies of bacteriophage T4 has indicated that it is a particularly interesting and informative model system in which to study aspects of the repair of damaged DNA. It is clear that the phage codes for a dimer excision enzyme system and also for products that appear to be involved in a recombination type of repair process. Further studies on the specificity of the T4 uv endonuclease, complete characterization of the phage-induced dimer excision enzymes, and elucidation of the nature and function of the x and y gene products should provide a fairly detailed understanding of the molecular biology of T4 DNA repair. (auth)

**28173** INHIBITION OF PROTEIN SYNTHESIS IN CULTURED TOBACCO CELLS BY ULTRAVIOLET RADIATION. Murphy, T. M.; Wright, L. A. Murphy, J. B. (Univ. of California, Davis). Photochem. Photobiol.; 21: No. 4, 219–225(Apr 1975).

Ultraviolet (254 nm) irradiation of liquid-cultured tobacco cells strongly and quickly inhibited their ability to incorporate labeled amino acids into protein. An incident dose of only 388 $J/m^2$ reduced incorporation to 37 per cent of the original rate. The effect on amino acid incorporation did not seem to depend on inhibition of amino acid uptake, inhibition of the supply of nucleoside triphosphates, or inhibition of the supply of messenger RNA to cytoplasmic ribosomes. (auth)

**28174** ATP-DEPENDENT DNAase FROM ESCHERICHIA COLI rorA: A NUCLEASE WITH CHANGED ENZYMATIC PROPERTIES. van Dorp, B.; Renne, R.; Palitti, F. (Rijksverdedigingsorganisatie TNO, Rijswijk, Netherlands). Biochim. Biophys. Acta; 395: No. 4, 446–454(Jul 1975).

The ATP-dependent DNAases from Escherichia coli wild-type and rorA were isolated and purified and their enzymatic properties were compared. The enzymes were found to differ in the amount of ATP that is consumed during DNA degradation. This difference can be influenced by the reaction conditions and the nature of the substrate. (NL)

**28175** NEW TRENDS IN PHOTOBIOLOGY. Proceedings of an International Symposium Held July 15–20, 1973, at Rio de Janeiro, Brazil. Caldas, L. R. (ed.) (Univ. of Rio de Janeiro). An. Acad. Brasil. Cienc., Supl.; 45: 1-226(1973). (In Spanish and English). (CONF-730730–).

From symposium on new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

The symposium dealt with the basic chemistry and biology of ultraviolet and visible irradiation of cellular systems and their component molecules. Physiological aspects are discussed. One paper is presented on the direct use of solar radiation for energy conversion using photosynthesis. Separate abstracts were prepared for 12 papers. (CH)

*For abstracts of individual papers see: 28176–28179, 28200, and 28216–28222.*

**28176** ULTRAVIOLET AND PHOTODYNAMIC INACTIVATION OF LYSOZYME. Grossweiner, L. I. (Illinois Inst. of Tech., Chicago). An. Acad. Brasil. Cienc., Supl.; 45: 45-52(1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

A review is presented of recent work on the ultraviolet and photodynamic inactivation of lysozyme in vitro, with emphasis on the initial photochemical processes and their relationship to the permanent changes. The interpretation in terms of the tertiary structure and published fluorescence results provides information about the properties of the native enzyme as well as the radiation damage per se. (auth)

**28177** INHIBITING EFFECT OF CAFFEINE ON THE INDUCTION OF SKIN CANCER IN THE MOUSE BY ULTRAVIOLET RADIATION. Zajdela, F.; Lstarjet, R. (Institut du Radium, Biologie, Orsay, France). An. Acad. Brasil. Cienc., Supl.; 45: 211-213(1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

Mice were exposed to the radiation of a medium-pressure mercury vapor lamp under such conditions that, in the controls, 90% of the ears developed a cancer in 1 year. During the experiment, the right ears were painted with a solution of caffeine before each irradiation, the left ears being the controls and painted with solvent only. Caffeine was chosen for its ability to inhibit the repair of uv-induced lesions in nucleic acid. The incidence of cancer was approximately 90% on the left ears and only 50% on the right ears. This result favors the hypothesis that cancer, in this case, results from a misrepair of primary uv-induced lesions in the nucleic acid. (auth)

**28178** RELEVANCE OF PHOTOBIOLOGICAL REPAIR. Setlow, R. B. (Oak Ridge National Lab., TN). An. Acad. Brasil. Cienc., Supl.; 45: 215-220(1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

Many biological systems are able effectively to repair uv-induced damage to their DNAs. The molecular mechanisms involved in the photoreactivation of radioinduced lesions of DNA are discussed. (CH)

**28179** PHOTOPRODUCTS AND THEIR SIGNIFICANCE IN RADIATION DAMAGE REPAIR. Riklis, E. (Nuclear Research Center-Negev, Beer Sheeva, Israel). An. Acad. Brasil. Cienc., Supl.; 45: 221-26(1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

The role of photoproducts formed during the uv irradiation of DNA in vitro and in bacteria in the repair of radiation injuries is reviewed. (CH)

**28180** DNA REPAIR IN E. COLI AFTER X IRRADIATION AND ITS RELEVANCE TO MAMMALIAN SYSTEMS. Town, C. D. (Univ. of Edinburgh, Scotland). pp 157-163 of Cell Biology and Tumor Immunology. Vol. I. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A review is given of the findings on cellular and subcellular level in cells of patients suffering from xeroderma pigmentosum. Special emphasis is laid on the DNA repair mechanism. (NL)

**28181** CHEMICAL NATURE OF LESION PRODUCED IN DNA BY IONIZING RADIATION. Hagen, U. (Kernforschungszentrum, Karlsruhe, Ger.). pp 77-82 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A review is given of the factors that modify radiation-induced DNA damage. Also the species that are formed during and following irradiation of DNA are discussed. (NL)

**28182** ENZYMATIC REPAIR OF DNA DAMAGE IN BACTERIA. Dean, C. J.; Lett-Brown, M. A. (Chester Beaty Research Inst., Sutton, Eng.). pp 91-97 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Bacterial cells contain at least two enzymatic pathways for the restitution of radiation-induced DNA lesions by excision repair. In E. coli and most probably other bacteria also, the major pathway for elimination of these defects is mediated via DNA-polymerase I and ligase. An alternative pathway probably involving DNA polymerase III is also present but would appear to be less efficient than the polymerase I system. (NL)

**28183** ENZYMATIC REPAIR OF DNA IN MAMMALIAN CELLS. Lett, J. T. (Colorado State Univ., Fort Collins). pp 98-104 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Data indicate that it is not gross DNA damage which is related to cell lethality, but rather DNA damage of specific types or at specific sites which is crucial. This damage is probably involved in, or is implicit to the overall structural integrity of the chromosome. (NL)

**28184** DNA DAMAGE-REPAIR STUDIES WITH CHEMOTHERAPEUTIC AGENTS AND RADIATION. Elkind, M. M. (Argonne National Lab., IL). pp 122-129 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Experiments characterized quite different effects between nitrogen mustard and actinomycin D in respect to radiation damage in DNA. On the basis of survival studies on Chinese hamster cells, it is concluded that nitrogen mustard acts quite differently from radiation but that actinomycin D and radiation have similarities in their actions. (NL)

**28185** RADIATION INDUCED STRAND BREAKAGE IN SUPERINFECTING PHAGE λ DNA MOLECULES. The Production of Strand Breaks, the Time Course in Rejoining of Broken Molecules, and the Effect of Oxygen. Johansen, I. (Univ. of Oslo). pp 130-135 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

The yield of single-strand breaks in phage λ DNA within lipogenic host bacteria was enhanced fourfold in oxygen as compared to anoxic conditions. No mechanism for repair operating within a fraction of a second was found. Strand breaks in the presence of oxygen were repaired in 30 to 40 seconds; those produced under anoxia rejoined even slower. It is suggested that in strand breakage, oxygen and hydrogen donors compete for reactions with radiation-induced transients in the DNA. (NL)

**28186** MOLECULAR MECHANISMS OF RADIATION-INDUCED DAMAGE TO NUCLEIC ACIDS. Ward, J. F. (Univ. of California, Los Angeles). Adv. Radiat. Biol.; 5: 181-239(1975).

The integrity of DNA is essential for the well-being of a cell. Damage to this molecule, whether caused by reaction with chemical mutagens, by irradiation with ultraviolet (uv) light, or by ionizing radiation, has dire consequences. Thus, much effort has been expended in attempting to understand the effects of these agents on DNA. The intent of this review is to describe some of the chemical mechanisms whereby DNA is damaged by ionizing radiation. The major advances in understanding of molecular mechanisms have come from studies of simple model systems, and it is these systems that are considered in this review. To place the various model systems in perspective the general mechanisms of the conversion of energy to damage in a cellular system are discussed. Against this background, all the model systems discussed in the review are judged as to their validity to the in vivo situation. The major part of the review is devoted to data derived from aqueous systems. The goal of the discussion is to describe at a molecular level radiation-induced reactions which would account for the DNA damage observed after in vivo irradiations: base damage and strand breaks. (200 references) (auth)

**28187** BACTERIOSTATIC ACTIVITY OF VARIOUS ANTIBIOTICS AFTER GAMMA-RAY IRRADIATION. Fleurette, J.; Madier, S.; Transy, M. J. (Hopital Cardiologique, Lyon). pp 239-251 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In French).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The purpose of the work described was to discover whether the antibiotics used in medicine can be sterilized by gamma rays; in this preliminary study, only the antimicrobic activity—the principal criterion for this type of medicament—was evaluated. Thirty-three products belonging to the various families of antibacterial and antifungic antibiotics were studied. The substances were irradiated in the dry state and in an aqueous solution, using a caesium-137 irradiator. The antibacterial and antifungic activity before and after irradiation was investigated by the method of diffusion in geiose. When irradiated in the dry state, 14 antibiotics preserve normal activity up to a dose of 10 Mrad; at doses between 5 and 10 Mrad, 15 other antibiotics are subject to a variable, but moderate, loss activity; and four register a slight loss of activity at a dose of 2.5 Mrad. In an aqueous solution all but two of the antibiotics suffer total loss of activity at a dose of 2.5 Mrad. As most commercial antibiotics are supplied in the dry state, gamma irradiation may be a useful sterilization process. However, preparations such as eye lotions, suspensions, ointments, etc. should be excepted. (auth)

**28188** IRRADIATED COBRA (NAJA NAJA) VENOM FOR BIOMEDICAL APPLICATIONS. Kankonkar, S. R. (Haffkine Inst., Bombay); Kankonkar, R. C.; Gaitonde, B. B.; Joshi, S. V. pp 253-262 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Ionizing radiation is known to cause damage to proteins in aqueous solutions in a selective manner, thereby producing remarkable changes in their properties. Since venoms are very rich in proteins, it was felt that they would also show such changes upon irradiation. It was of interest to know if one could get rid of the toxicity and retain the immunogenicity of the venom by suitable choice of radiation dose and strength of venom solution. If so, the method could be profitably exploited for the rapid preparation of venom toxoid and this could be expected to have many applications in the biological sciences. Accordingly, laboratory investigations were undertaken on the effect of gamma radiation on cobra (Naja naja) venom. To avoid drastic changes, solutions of cobra venom having low protein content were irradiated with gamma radiation from a cobalt-60 source. The results obtained with 0.01 to 1.0% venom solutions are found to be encouraging. The solutions did not manifest any toxicity in mice. For the immunogenicity test, guinea pigs were immunized with varying doses of

the irradiated cobra venom and the immunized guinea pigs were found to survive when challenged with as big a dose as 10 MLD (i.e. minimum lethal dose, approximately 1 mg). (auth)

**28189** RADIATION STERILIZATION OF PHARMACEUTICALS AND BIOMEDICAL PRODUCTS. Blackburn, R.; Iddon, B.; Moore, J. S.; Phillips, G. O.; Power, D. M.; Woodward, T. W. (Univ. of Salford, Eng.). pp 351-363 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Sterilization of pharmaceuticals by radiation is accompanied by chemical degradation which must be eliminated or minimised if the method is to be successfully applied. In order to devise ways in which the pharmaceutical can be protected it is necessary to know the yield and nature of the decomposition products, the mechanisms by which degradation occurs, and the rate constants for the reactions involved. We have obtained such data for a variety of pharmaceutical compounds, viz. vitamin B12, benzyl penicillin, sulphonamides, indoles, heparin, alginates and phenylmercurics, both in the solid state and in aqueous solution. The scope and limitations of radiation sterilization are discussed in the light of these results. (auth)

**28190** PHOTOLABILITY OF DNA CONTAINING 5-BROMOURACIL. I. Single-strand Breaks and Alkali-labile Bonds. Hewitt, R. R.; Marburger, K. (Univ. of Texas, Austin). Photochem. Photobiol.; 21: No. 6, 413-417(Jun 1975).

The proportions of single-strand breaks and alkali-labile bonds produced by uv-light were investigated in covalently-closed circular 5-bromouracil (BrUra)-containing λ-phage DNA. When BrUra-DNA was irradiated in 0.01M Tris-0.001M EDTA (pH 8.1) buffer, the $D_Q$ was 11.7 J/m$^2$ for single-strand breaks, 2.25 J/m$^2$ for total breaks, and 2.8 J/m$^2$ for alkali-labile bonds. Thus, alkali-labile bonds were the predominant photochemical products. No double-strand breaks were observed after exposure to 7.7 times the $D_Q$ for neutral breakage. The photolability measured under both neutral and alkaline conditions was affected by the NaCl concentration in the irradiation solvent, with the greatest resistance to breakage exhibited at the lowest concentrations. The composition of the irradiation buffer also affected sensitivity. Exposure in 1/10 SSC yielded 4.4 (neutral) and 5.7 (alkaline) times the breakage produced in Tris-EDTA. (auth)

**28191** ACTION OF IONIZING RADIATION ON DNA IN THE PRESENCE OF QUINACRINE. I. UV ABSORPTION AND FLUORESCENCE MEASUREMENTS. Hissung, A.; Dertinger, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Strahlenbiologie); Heinrich, G. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Radiochemie). Radiat. Environ. Biophys.; 12: No. 1, 5-12(Jun 1975).

7 figs.; 19 refs.

It is shown by UV absorption and absolute fluorescence spectroscopy of solutions containing both DNA and quinacrine that the components experience mutual radioprotection due to scavenging of water radicals. From measurements at different ionic strengths it is inferred that quinacrine bound to DNA is more efficiently protected than the free compound. Furthermore, release of bound quinacrine from DNA is observed at higher doses. (GE)

**28192** IMMUNOLOGICAL RECOGNITION OF SPECIFIC ANTIGENIC DETERMINANTS IN UV- AND GAMMA-IRRADIATED PHAGE DNA. Hotz, G. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Strahlenbiologie). Radiat. Environ. Biophys.; 12: No. 1, 41-50(Jun 1975).

4 figs.; 13 refs.

Thermally denatured DNA of coliphage T1 after treatment with UV-light (2,537 A) and $^{60}$Co-gamma rays acts as a hapten with antigenic determinant groups specific for radiation-induced alterations of the macromolecule. After conjugation to methylated bovine serum albumin the DNA becomes immunogenic in rabbits. Antibodies against irradiated DNA do not react with unirradiated single-stranded DNA. Antigen-antibody complexes were demonstrated by CsCl-density gradient centrifugation. The decrease in buoyant density of the DNA is proportional to the amount of antibody protein bound to the antigen. By this means photoproducts as well as alterations due to ionizing radiation in DNA were detected independent of the type of antigen-antibody complex, i.e. precipitating or soluble aggregate. (GE)

**28193** ACTION OF IONIZING RADIATION ON DNA IN THE PRESENCE OF QUINACRINE. II. DNA Strand Breakage. Hissung, A.; Dertinger, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Strahlenbiologie). Radiat. Environ. Biophys.; 12: No. 1, 13-22(Jun 1975).

7 figs.; 4 tabs.; 11 refs.

Strand breakage of DNA irradiated in solution and in the dry state in the presence of quinacrine was investigated by sedimentation analysis. Determination of single strand breaks in solution combined with binding studies permits to conclude that bound quinacrine protects DNA more effectively than the free compound. In the dry state quinacrine is without detectable effect on both single and double strand break formation, neither under aerobic nor anaerobic conditions. (GE)

**28194** EXCISION OF PYRIMIDINE DIMERS FROM THE NUCLEAR DNA OF A HAPLOID RESPIRATION-DEFICIENT ($\rho^-$) STRAIN OF SACCHAROMYCES CEREVISIAE. Waters, R.; Moustacchi, E. (Institut du Radium, Orsay, France). Photochem. Photobiol.; 21: No. 6, 441-444(Jun 1975).

A haploid respiration-deficient ($\rho^-$) mutant of Saccharomyces cerevisiae exhibits a lower ability to excise ultraviolet-induced pyrimidine dimers in various post-irradiation treatments as compared to the original respiration-competent wild-type strain. This decrease in excision may account for the inability of $\rho^-$ strains to show liquid-holding recovery. (auth)

**28195** PROPERTIES OF THE ULTRAVIOLET-LIGHT-MEDIATED BINDING OF BOVINE SERUM ALBUMIN TO DNA. Braun, A.; Merrick, B. (Brandeis Univ., Waltham, MA). Photochem. Photobiol.; 21: 243-247(1975).

The binding of DNA to protein mediated by uv (254 nm) radiation has been investigated using binding of the complex to Millipore membrane filters as an assay technique. The reaction proceeds through an activated protein intermediate which then reacts with the DNA. The activated protein has a half-life of about 75 min at 0$^0$C and about 18 min at 37$^0$C. Short wavelengths are more efficient in forming the complex than wavelengths in the 250-280 nm range. N-ethyl maleimide treatment of protein before irradiation markedly inhibits the reaction. (auth)

## Radiation Effects on Cells

*Refer also to abstracts 28173 and 28275.*

**28196** (COO-1671-64) THEORY OF RBE. Progress Report, 1 January 1975–31 December 1975. Katz, R. (Nebraska Univ., Lincoln (USA)). Sep 1975. Contract E(11-1)-1671. 8p. Dep. NTIS $4.00.

Calculations from the theory of RBE have been so simplified that RBE, D/sub x/, and oxygen enhancement ratio for a mixed radiation environment (say, pions, neutrons, and gamma-rays) can be calculated with an HP-65 pocket programmable calculator, once equivalent track segment bombardments have been found for the components of the mix, from theory or from experiment. With a least-squares seeking computer program, cellular radiosensitivity parameters have been evaluated (with 95 percent confidence limits) for many biological cells for which survival data is available at different LET's. Typically there is good agreement with visually fitted parameters, with confidence limits ranging from a few percent on up, depending on the quantity and quality of the data. The procedure reveals internal inconsistencies in the data, and may be used as the basis for the design of efficient experiments. Studies of many-hit nuclear emulsions have been initiated. These emulsions will exhibit RBE-LET properties similar to those of biological cells and tissues, and will be useful as a model system in studies of low-dose and dose-rate effects in radiobiology. A first quantitative result is that Ilford K-1 emulsion is an 8 +- 1 or-more hit detector. (auth)

**28197** RADIOSENSIBILISATION OF TUMOR CELLS WITH MICROWAVES: THE END OF THE OXYGEN EFFECT. Dietzel, F. (Giessen Univ. (F. R. Germany). Zentrum fuer Radiologie). Naturwissenschaften; 62: No. 1, 44-45(Jan 1975). (In German).

A local application of microwaves (461.04 MHz) to Ehrlich ascites tumors leads to a radiosensibilization of the tumor, so that tumor reduction and survival curves increase significantly in comparison with normal radiotherapy. At higher intra-tumoral temperatures, the effect of heat on cell proliferation becomes more prominent. The results suggest that thermal methods of radiotherapy may compensate the oxygen effect (OER) in weakly ionizing radiation. (GE)

**28198** SPECTRA OF COLONY SIZE OF CHO-FIBROBLASTOMA IRRADIATED WITH $^{60}$Co GAMMA RAYS AFTER FREEZE AND THAW CYCLES. Toellner, D.; Nachtegal, H.; Hagemann, G.; Deinhardt, J. (Medizinische Hochschule Hannover (F. R. Germany). Inst. fuer Klinische Radiologie). Strahlentherapie; 149: No. 5, 520-527(May 1975). (In German).

The production of reproductive lethal cell lesions by freeze and thaw cycles was studied by means of colony size spectrometry in tetraploid CHO-fibroblastoma protected with glycerine. The verification sensitivity of this method is compared with that of the colony formation test, the survival curve of cells

and the relative multiplicity. Twenty days after a freeze and thaw cycle the spectrometry of the colony size and the survival curve of the cells and colonies suggest a cell lesion. After 44 days, changes as a consequence of reproductive lethal lesions can be detected in the spectrum of the colony size. Survival curves of the colonies, survival curves of the cells, and relative multiplicities determined on cell strains 44 days after a freeze and thaw cycle are not significatively different from the results of non-frozen control cells. The relation of the average cellular multiplicity after a freeze and thaw cycle to that of the nonfrozen control cells approaches the value of 1 with increased cultivation period after a freeze and thaw cycle. The reproductive lethal lesion after a freeze and thaw cycle is also decreasing with an increased cultivation period. Proliferation lesions by means of $^{60}$Co gamma irradiation were influenced in dependence of the dose by 20 days of freeze and thaw lesions of a cell population. (GE)

**28199** EFFECT OF IN VITRO IRRADIATION ON THE RESPONSES OF HUMAN LYMPHOCYTES TO PHA, PPD, AND ALLOGENEIC CELLS. Herva, E.; Kiviniitty, K. (State Public Health Lab., Oulu (Finland); Oulu Univ. (Finland). Dept. of Radiotherapy). Strahlentherapie; 149: No. 5, 504-512(May 1975).

The effect of X-ray, cobalt, and 45-MeV electron irradiation on the responses of lymphocytes to PHA, PPD, and allogeneic cells was studied using a semimicro lymphocyte culture technique. The responses to PPD and allogeneic cells were found to be more sensitive to irradiation that the response to PHA, even when the time factor was taken into account, i.e., the effect of irradiation was measured on the same day irrespective of the type of stimulation. At the doses used, 500, 3,000, and 6,000 rd, there was no difference between the effects of the three types of radiation used. The possible explanations for the findings are discussed. (GE)

**28200** ULTRAVIOLET-SENSITIVE AND RESISTANT MUTANTS PRODUCED IN HeLa S3 CELLS AND THEIR REPAIR MECHANISMS. Klimek, M.; Sevcikova, P.; Vlasinova, A. M.; Oltova, A. (Inst. of Biophysics, Brno). An. Acad. Brasil. Cienc., Supl.; 45: 147-150(1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

Subclones of the clone of HeLa S3 cells were obtained, many of which were more sensitive than the original clone. Two resistant subclones were isolated. The resistant strains were found as hyperpentaploid subclones. (CH)

**28201** INTRAGENOMAL DISTRIBUTION OF DNA REPAIR SYNTHESIS IN CULTURED HUMAN AND MOUSE CELLS DAMAGED WITH CHEMICAL CARCINOGENS AND ULTRAVIOLET RADIATION. Lieberman, M. W. (National Inst. of Environmental Health Sciences, Research Triangle Park, NC). pp 149-152 of Cell Biology and Tumor Immunology. Vol. I. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Damage of genomes in the mammalian cell is partially or totally repairable. This implies that the repair synthesis associated with excision may be an error-free process in mammalian cells as well as in bacteria. It appears that repair synthesis is template-directed. (NL)

**28202** POSTREPLICATION REPAIR OF DNA CONTAINING PSORALEN ADDITION PRODUCTS IN CHINESE HAMSTER CELLS. Ben-Hur, E. (Hebrew Univ., Jerusalem); Elkind, M. M. pp 170-175 of Cell Biology and Tumor Immunology. Vol. I. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Exposure of many biological systems to near ultraviolet radiation in the presence of psoralens produces lethal, mutagenic, and carcinogenic effects. It is thought that psoralens react with pyrimidine bases and form crosslinks in DNA. It is possible that postreplication repair occurs in mammalian cells containing pyrimidine monoadducts and pyrimidine-pyrimidine crosslinks in their DNA. (NL)

**28203** DNA-SYNTHESIS IN SYNCHRONIZED L-CELLS AFTER IRRADIATION DURING THE $G_1$-PHASE OF THE CELL CYCLE. Koenig, K.; Linden, W. A.; von Canstein, M.; Baisch, H.; von Canstein, L. (Hamburg Univ. (F. R. Germany). Inst. fuer Biophysik und Strahlenbiologie). Radiat. Environ. Biophys.; 12: No. 1, 23-30(Jun 1975).

3 figs.; 21 refs.

Mouse fibroblast L-929 cells synchronized by mitotic selection were irradiated during the $G_1$-phase of the cell cycle with a dose of 1,000 rad. The rate of DNA synthesis was measured by $^3$H-thymidine incorporation, and the progression of the cells through the cell cycle was determined using a pulse-cytophotometer. Irradiation caused a decrease in the rate of DNA synthesis to half the control value, and an extension of the S-phase to twice its normal duration. (GE)

## Radiation Effects on Microorganisms

*Refer also to abstracts 28125, 28138–28140, 28147, 28166, 28172, 28174, 28180, 28182, 28185, 28194, and 28302.*

**28204** REPAIR OF DAMAGE INDUCED BY ULTRAVIOLET RADIATION IN MUTATOR T-1 ESCHERICHIA COLI TRANSDUCTANTS. Sideropoulos, A. S.; Greenberg, J.; Warren, G. (Medical Coll. of Pennsylvania). J. Am. Med. Women's Assoc.; 30: No. 2, 65-67; 70-71(Feb 1975).

To ascertain whether a relationship commonly exists between azide resistance, ultraviolet (uv) resistance, and the mutator property (mut T-1), we performed uv survival and mutation frequency determinations with and without caffeine (2.571 mM) in nonmutator azide resistant (azi/sup r/) and phage mediated mut T-1 transductants of Escherichia coli K-12, B/r, B/r T$^-$, Bs-1, and Bs-8. The strains constructed were assumed to be "co-isogenic" except for the mutator factor. The frequency of mutation to streptomycin resistance (str/sup r/) was relatively constant and approximated 2 x 10$^{-7}$. Transductants carrying the azide marker with or without the mut T-1 gene had the same level of uv survival as the parent with the same mutator phenotype. Dark repair of the prelethal uv lesion is equally caffeine sensitive in the nonmutator and mutator HCR$^+$ strains. Our results indicated that the mut T-1 strains possess an efficient dark repair system for uv damage and that the mechanism of mut T-1 action is independent of uv dark repair processes. (auth)

**28205** PHOTOREACTIVITY OF HYDROXYPSORALENS AND THEIR PHOTOBIOLOGICAL EFFECTS IN BACILLUS SUBTILIS. Song, P. S.; Mantulin, W. W.; McInturff, D.; Felkner, I. C.; Harter, M. L. (Texas Tech. Univ., Lubbock). Photochem. Photobiol.; 21: No. 5, 317-324(May 1975).

Although psoralen and many substituted psoralens are potent skin-photosensitizing agents, hydroxypsoralens are not. A satisfactory molecular interpretation of this structural specificity has been given in terms of dissociation of the hydroxyl group of 5- and 8-hydroxypsoralens in their excited states. The dissociation process in the $S_1$ state effectively competes with $S_1 \rightarrow T_1$ intersystem crossing, thus reducing the photoreactive $T_1$ population. The $T_1$ states of the anions are more delocalized than those of neutral psoralens so that they are less reactive toward photocycloaddition with pyrimidine bases of DNA. The lack of significant phosphorescence of hydroxypsoralens in ionizing solvent or in the presence of base at low temperatures (14 to 77°K) indicated ineffective $S_1 \rightarrow T_1$ and/or effective $T_1 \rightarrow S_0$ intersystem crossing. These factors make hydroxypsoralens unreactive, electronically and kinetically, as skin photosensitizers, which are known to react with DNA. In correlation with the hydroxypsoralens' spectroscopic characterization, they were also found to be ineffective or less effective photosensitizers in Bacillus subtilis. (auth)

**28206** X-RAY SENSITIVITY OF PHOTOSYNTHESIS AND REPRODUCTIVE SYSTEMS IN CHLORELLA. Nokes, M. A.; Simic, M. (Univ. of Texas, Austin). Photochem. Photobiol.; 21: No. 4, 265-268(Apr 1975).

Some effects of x rays on the green alga Chlorella pyrenoidosa have been investigated by measurements of survival and oxygen-evolving capability. Photosynthetic oxygen evolution at light saturation and endogenous respiration showed the same radiation sensitivity, and these two processes were about 40 times more resistant to x-ray-induced inactivation than survival. Responses of cells receiving doses in excess of 200 krad were in agreement with the existence of two photosystems, photoreaction II being apparently more sensitive to x rays than photoreaction I. (auth)

**28207** ULTRAVIOLET IRRADIATION OF SUSPENSIONS OF MICROORGANISMS: POSSIBLE ERRORS INVOLVED IN THE ESTIMATION OF AVERAGE FLUENCE PER CELL. Jagger, J.; Fossu, T.; McCaul, S. (Univ. of Texas, Dallas). Photochem. Photobiol.; 21: No. 5, 379-382(May 1975).

Experiments on cell survival in concentrated suspensions of Escherichia coli B/r showed that application of the well known "Morowitz correction" (H. J. Morowitz, (1950) Science 111, 229-230) could lead to large errors in estimation of the average fluence per cell if light scattering was not taken into account. The magnitude of the effect is illustrated for this organism, but it is pointed out that experimenters should determine the correction for each organism and set of experimental conditions used. (auth)

**28208** PHOTOPROTECTION OF E. COLI B/r: RESPIRATION, GROWTH, MACROMOLECULAR SYNTHESIS, AND REPAIR OF DNA. Swenson, P. A.; Ives, J. E.; Schenley, R. L. (Oak Ridge National Lab., TN). Photochem. Photobiol.; 21: No. 4, 235-241 (Apr 1975).

Photoprotecting effects of near uv radiations (300 to 400 nm, maximum at 360 nm) against far uv radiations (primarily 254 nm) have been studied in Escherichia coli B/r cells in minimal medium with glycerol as a carbon source. Near uv light ($10^5$ J · $m^{-2}$) had a negligible effect on survival, but caused transitory inhibition of respiration, growth, DNA, RNA and protein syntheses, and cell division. Far uv (52 J · $m^{-2}$) reduced survival to about 0.5%; respiration, growth, and RNA and protein syntheses proceeded for about 60 min, after which they nearly ceased for several hours. Near uv given before this fluence of far uv increased survival 10-fold and the above processes resumed at times and with kinetics characteristic of those produced by lower fluences of far uv. Single-strand breaks appeared in the DNA of both unprotected and photoprotected cells; repair of the breaks was essentially complete in protected but not unprotected cells. The viability kinetics for far-uv-irradiated cells with and without photoprotecting treatment were identical except that the curve for the latter was displaced upward about 1 log; exponential increases (cell division) began at 120 min in each case. The data suggested that, in B/r cells grown under our particular conditions, namely in minimal medium with glycerol, photoprotection was not the result of growth or division delays, but reflected an increased repair capability due to continued respiration. (auth)

**28209** ULTRAVIOLET SENSITIVITY AND PHOTOPRODUCTS IN SPORE-LIKE BODIES OF AN EXCISION-REPAIR-DEFICIENT AND DIPICOLINIC-ACID-LESS STRAIN OF BACILLUS SUBTILIS. Munakata, N. (Univ. of Western Ontario, London); Fitz-James, P. C.; Young, I. E. Can. J. Microbiol.; 21: No. 7, 1129-1132 (Jul 1975).

Bacillus subtilis strain UVS-42DPA is defective in both excision-repair capability and dipicolinic acid (DPA) accumulation. In sporulation medium, it forms spore-like bodies, which are as sensitive to ultraviolet light (uv) as the vegetative cells and produce mostly cyclobutane dimers instead of spore photoproduct upon uv irradiation. The results suggest that the drastic change in the photochemical reactivity of DNA during sporulation might be induced and (or) maintained by the accumulation of DPA. (auth)

**28210** INTERACTIVE EFFECT OF ULTRAVIOLET IRRADIATION AND 5-BROMOURACIL AT THE RIB-1 LOCUS IN NEUROSPORA CRASSA. Nemerofsky, A. (State University Coll., New Paltz, NY). Can. J. Genet. Cytol.; 17: No. 2, 275-278(Jun 1975).

5-Bromouracil (5-BU) was shown to enhance reverse mutation rates when added to conidia of a rib-1 strain of Neurospora crassa previously irradiated with ultraviolet light. A comparison is presented between various incubation intervals in the presence and absence of 5-BU while varying the uv dose. An increase in mutation frequency ranging from 0.028 to $2.05 \times 10^2$ times greater than the spontaneous frequency, uv frequency alone, or 5-BU frequency alone was observed when uv irradiation and 5-BU were combined. (auth)

**28211** INDUCTION OF MUTATION TO STREPTOMYCIN RESISTANCE IN MICROCOCCUS RADIODURANS. Kerszman, G. (Danish Atomic Energy Commission, Risoe). Mutat. Res.; 28: No. 1, 9-14(Apr 1975).

No detectable induction of mutation to streptomycin resistance could be caused in wild-type Micrococcus radiodurans and its radiation-sensitive and super-resistant mutants by ionizing or uv radiation. N-methyl-N'-nitro-N-nitrosoguanidine (NTG) was mutagenically active. The results suggest that repair of radiation-damaged DNA in Micrococcus radiodurans is mutation proof. (NL)

**28212** PLEIOTROPIC EFFECTS OF A DNA ADENINE METHYLATION MUTATION (dam-3) IN ESCHERICHIA COLI K12. Marinus, M. G.; Morris, N. D. (Coll. of Medicine and Dentistry of New Jersey, Piscataway). Mutat. Res.; 28: No. 1, 15-26(Apr 1975).

The dam-3 mutation results in a five-fold reduction in the number of 6-methyl adenine (6-meA) residues in the DNA of Escherichia coli K12 or phage λ. The DNA of phage fd appears to be devoid of 6-meA when propagated on dam-3 bacteria. The phenotypic differences between dam-3 and $dam^+$ bacteria include: (1) increased free phage in lysogenic dam-3 cultures, (2) inviability of dam-3lex-1 strains, (3) lower molecular weight of DNA in dam-3 bacteria in the absence of DNA ligase, and (4) increased rate of DNA degradation in dam-3recA strains. (NL)

**28213** AZAGUANINE-RESISTANT MUTANTS INDUCED BY SEVERAL MUTAGENS IN A NEUROSPORA HETEROKARYON. Hoffmann, G. R. (Meredith Coll., Raleigh, NC); Malling, H. V. Mutat. Res.; 27: No. 3, 307-318(Mar 1975).

The development of a new system for the detection of forward mutations in a heterokaryon of Neurospora crassa is reported. This system, designed to detect a wide variety of genetic alterations, is based upon the detection of 8-azaguanine-resistant mutants in an adenine-requiring heterokaryon carrying the aza-3 gene. Induction of mutations in the aza-3 gene was detected after treatment of conidia with ultraviolet light, X-rays, ethyl methanesulfonate (EMS), or the acridine mustard ICR-170. The pattern of appearance of mutant colonies and various factors in mutant selection are discussed. (NL)

**28214** 8-METHOXYPSORALEN PLUS 365 nm LIGHT EFFECTS AND REPAIR IN YEAST. Averbeck, D.; Moustacchi, E. (Institut du Radium, Orsay, France). Biochim. Biophys. Acta; 395: No. 4, 393-404(Jul 1975).

Haploid wild-type and mutant cells of Saccharomyces carrying one of the single genes $rad_{2-20}$ or $rad_{9-4}$ and the double mutant $rad_{2-20}rad_{9-4}$ were tested for their response to a treatment with 8-methoxypsoralen plus 365 nm light using immediate and delayed plating techniques. The mutants defective in the excision of ultraviolet-induced pyrimidine dimers ($rad_{2-20}$) as well as that presumably deficient in a recombinational repair system ($rad_{9-4}$) are more sensitive than wild type cells. The double mutant ($rad_{2-20}$ $rad_{9-4}$) demonstrates a higher sensitivity than each of the single mutants, indicating that at least two pathways are involved in the repair of the 8-methoxypsoralen plus 365 nm induced damages. In all cases survival curves have shoulders. The survival of wild type and $rad_{9-4}$ cells is increased after dark holding whereas it remains constant for the $rad_{2-20}$ mutant and for the double mutant. These results show that the induced damages are reparable. Respiratory deficient mutants ($p^-$) were compared to the corresponding respiratory competent cells. It is shown that the respiratory function is required for the expression of the excision repair activity. The 8-methoxypsoralen plus 365 nm light treatment appears to be less effective than ultraviolet irradiation (254 nm) in the induction of the cytoplasmic "petite" mutation at the same survival levels. (NL)

**28215** TOXICOLOGIC AND HYGIENIC INVESTIGATION OF POTATOES IRRADIATED WITH A BEAM OF FAST ELECTRONS AND γ RAYS TO CONTROL SPROUTING. Zavec, A. N.; Shillinger, J. I.; Kamaldinova, Z. M.; Osipova, I. N. (Inst. of Nutrition, Moscow). Toxicology; 4: No. 3, 267-274(Jul 1975).

Potatoes exposed either to γ rays at a dose of 20 krad, or irradiated with a beam of fast electrons at a dose of 30 krad to inhibit the sprouting of tubers, were studied for mutagenic effects. Toxic action and influence on the fertility were also investigated. Extracts of irradiated potatoes (10 krad γ-rays), stored and then boiled, were also studied for their mutagenic effects. The induction of dominant lethal mutations (DLM) was used as indicator of mutagenic action of potatoes in male rats, that of the extracts of potatoes in male mice. Experimental animals (white rats) were fed with irradiated potatoes. Neither a toxic, nor a mutagenic action was found. Oral treatment of male mice with extracts of irradiated potatoes also did not increase the frequency of DLM in male mice. (NL)

**28216** SENSITIZATION AND REPAIR IN ULTRAVIOLET-IRRADIATED BACTERIA. Alcantara Gomes, R.; Leitao, A. C.; Aragao, B. R.; Caldas, L. R. (Universidade do Estado da Guanabara, Rio de Janeiro). An. Acad. Brasil. Cienc., Supl.; 45: 123-133(1973).

From new trends in photobiology; Rio de Janeiro, Brazil(15 Jul 1973).

The effects of reductone on excision and recombinational repair in uv-irradiated E. coli were studied and compared with those produced by caffeine. It was shown that reductone and caffeine interfere with excision repair but have no effect on recombinational repair. In uv-irradiated cells reductone can reduce the extent of photoreactivation, and prior photoreactivation of uv-irradiated cells can reduce the effect of reductone. It was also shown that the incision step is not altered by reductone, but the DNA degradation after uv-irradiation is blocked. (CH)

**28217** PRIOR IRRADIATION CAN SENSITIZE OR PROTECT BACTERIAL CELLS FROM SUBSEQUENT IRRADIATION: A GENETIC AND BIOCHEMICAL STUDY. Smith, K. C.; Martignoni, K. D. (Stanford Univ., CA). An. Acad. Brasil. Cienc., Supl.; 45: 135-145(1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

When wild-type cells of E. coli K-12 were uv irradiated just prior to x irradiation, they were rendered much more sensitive to the killing action of x rays. This synergistic effect of combined uv and x irradiation was also observed, but to a reduced extent, in uvrA, uvrB, uvrC, and pol A mutants but was absent

in exrA, recA, recB, and recC mutants of E. coli K-12. Alkaline sucrose gradient studies demonstrated that the rec and exr gene-controlled, growth-medium-dependent (Type III) repair of x-ray-induced DNA single-strand breaks was inhibited by prior uv irradiation. This inhibition probably explains the synergistic effect of these two radiations on survival. On the other hand, when log phase cells of E. coli K-12 were maintained in growth medium for varying periods of time between the first and second irradiation, the cells became progressively more resistant to the second irradiation. This was true regardless of whether the first irradiation was with uv or x radiation. The time to achieve maximum resistance, however, depended upon the nature of the first radiation used (i.e., ~60 min for x ray and several hours for uv radiation). (CH)

**28218** ENZYMES THAT REPAIR OR EDIT ULTRAVIOLET-IRRADIATED DNA. Grossman, L.; Braun, A.; Garvik, B.; Hamilton, L.; Mahler, I. (Brandeis Univ., Waltham, MA). Contract AT(30-1)-3449. An. Acad. Brasil. Cienc., Supl.; 45: 167-177(1973).

From new trends in photobiology; Rio de Janeiro, Brazil(15 Jul 1973).

The biological activity of B. subtilis transforming DNA inactivated by uv light can be repaired under biochemically controlled conditions, in which incision is catalyzed by a homogeneous sterile preparation of uv-endonuclease capable of high-efficiency incision. An enzyme with similar endonucleolytic properties has been isolated from E. coli and appears to be the product of two separate genes, uvrA and uvrB. Excision which can occur by an independent uv-exonuclease is described, as well as the excision repair carried out by the more efficient DNA polymerase-controlled excision and reinsertion. Polynucleotide ligase is apparently an important component of the in vitro repair system required to restore both the biological and physical properties of B. subtilis transforming DNA. (auth)

**28219** DNA REPAIR IN BACILLUS SUBTILIS: COMPARATIVE STUDIES WITH GAMMA-RAYS AND ULTRAVIOLET LIGHT. Kada, T.; Noguti, T.; Sadaie, Y. (National Inst. of Genetics, Mishima, Japan). An. Acad. Brasil. Cienc., Supl.; 45: 179-184 (1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

When cells of Bacillus subtilis were exposed to $\gamma$-rays or uv, toluenized, and incubated in a buffered mixture containing precursors and cofactors for DNA polymerase I and DNA ligase (4dNTP, $MG^{2+}$, and NAD), recovery of the transforming capacity of DNA extracted from the treated bacteria increased during incubation in the case of $\gamma$-rays but not in the case of uv. In the latter case, addition of ATP in the reaction mixture gave negative results. A cellular-protein, enhancing priming activity for DNA polymerase I of $\gamma$-irradiated DNA, was isolated and purified. This enzyme did not show any activity if DNA was not $\gamma$-irradiated or if it was exposed to uv. Suppression of DNA synthesis by uv irradiation was greater in recombination-deficient strains of B. subtilis than in wild-type strains. In toluenized cells, uv irradiation stimulated DNA synthesis when ATP was present in the reaction mixture in two recombinationless strains carrying new rec genes. However, this effect was not detectable in the absence of ATP. (auth

**28220** ULTRAVIOLET MUTAGENESIS IN BACTERIA: THE INDUCIBLE NATURE OF ERROR-PRONE REPAIR. Witkin, E. M. (Rutgers-The State Univ., New Brunswick, NJ). An. Acad. Brasil. Cienc., Supl.; 45: 185-191(1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

Experiments with tif-1 strain Escherichia coli strongly support the hypothesis that uv-induced mutations are caused by the action of an error-prone repair system which is inducible (or which includes one or more inducible components) and that the induction of this system is governed by the same genetic and physiological requirements that govern prophage induction, filamentous growth, and other uv-inducible functions expressible only in response to blockage of DNA replication and in the presence of $recA^+$ and $lex^+$ gene products. Blockage of DNA replication apparently triggers induction of a large cluster of functions (very possibly including some not yet known), which may be presumed to serve the special needs of cells which have sustained some form of chromosome damage. (auth)

**28221** REPAIR MECHANISMS INVOLVED IN THE RECOVERY OF PHAGE $\lambda$ FROM ULTRAVIOLET DAMAGE. Devoret, R.; Blanco, M.; George, J.; Radman, M. (Laboratoire d'Enzymologie, Gif-sur-Yvette, France). An. Acad. Brasil. Cienc., Supl.; 45: 193-202(1973).

From new trends in photobiology; Rio de Janeiro, Brazil(15 Jul 1973).

The mechanisms of different cellular processes involved in the recovery of Escherichia coli and phage DNA damaged by uv irradiation are reviewed. Two hypotheses to account for the mechanism of uv reactivation are presented that postulate either an enhanced efficiency of host-cell reactivation of the irradiated phage genome after uv irradiation of the host cell or the existence of some kind of recombination repair between homologous parts of the uv-irradiated host and phage genomes. (CH)

**28222** REPAIR PROCESSES AND DOSE-RESPONSE CURVES IN ULTRAVIOLET MUTAGENESIS OF BACTERIA. Bridges, B. A.; Rothwell, M. A.; Green, M. H. L. (Univ. of Sussex, Brighton, Eng.). An. Acad. Brasil. Cienc., Supl.; 45: 203-209 (1973).

From new trends in photobiology; Rio de Janeiro, Brazil (15 Jul 1973).

Data are presented that show that indirect induction by an irradiated colV plasmid of an error-prone repair system responsible for bacterial uv mutagenesis does not occur under conditions in which uv reactivation and uv mutagenesis of irradiated $\lambda$ do occur, suggesting that the system responsible for uv mutagenesis of E. coli and of $\lambda$ can be clearly distinguished, at least in this respect. Either the postulated error-prone repair system is not inducible indirectly, or it must be almost fully induced by the low uv doses given to the recipients. In the latter case the dose-squared characteristic of the response curve at all except the very lowest doses must be due to some other cause. An alternative hypothesis for the dose-squared response curve is examined, and it is proposed that a second, nonphotoreversible lesion is produced by uv and, possibly by inhibiting an alternative error-free pathway, results in an increasing proportion of the repair of pyrimidine dimers among the survivors being channeled through the error-prone system with increasing dose. Evidence is also presented suggesting that ionizing radiation produces a lesion that may enhance the mutagenicity of uv-induced pyrimidine dimers in a similar way. (auth)

**28223** EFFECTS OF TRITIATED WATER ON THE DIVISION RATE OF SPIROSTOMUM AMBIGUUM MINOR. Kasturi Bai, A. R.; Manjula, M. E. (Bangalore Univ. (India). Dept. of Zoology). Stimul. Newsl.; No. 6, 34-41(Dec 1974).

2 tabs.; 22 refs.

The effects of different doses of endogenous soft beta ray irradiation on the fission rate of the ciliate Spirostomum was studied. Groups of 4 ciliates were treated with tritiated water of 1, 1.5, 2.5, 3.75, and 5 mCi/ml. After 24 h, the number of ciliates was counted and all except 4 daughter individuals were removed. This process was repeated daily for 8 days. Low radiation doses had no effect on the morphology, behavior and fission rate. With increasing doses, the generation time is reduced after the 3rd day. If the doses increased further, the fission rate declined to 0. The fission rate was shown to be also temperature dependent. At low temperature, optimum radiation dose increased, while with increased temperature, it decreased. (GE)

**28224** INACTIVATION OF B. PUMILUS SPORES BY COMBINATION HYDROSTATIC PRESSURE-RADIATION TREATMENT OF PARENTERAL SOLUTIONS. Wills, P. A. (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). pp 45-51 of Radiosterilization of Medical Products, 1974. Vienna, International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Bacterial spores are inactivated by moderate hydrostatic pressures. The radiation dose required to sterilize radiation sensitive pharmaceuticals can be considerably reduced using a combination hydrostatic pressure-radiation treatment. This paper describes a combination pressure-radiation sterilization process using Bacillus pumilus spores suspended in water, 0.9% saline, and 5% dextrose solutions. The optimum temperatures for spore inactivation at 35 MPa and the degree of inactivation at 35, 70 and 105 MPa applied for times up to 100 min have been determined. Inactivation was greatest in saline and least in dextrose. Spores in dextrose were only slightly less radiation resistant than in saline or water. It was calculated that the radiation dose required for sterilization could be halved with appropriate compression treatment. Examples of combinations of pressure-radiation suitable for sterilization are given. One combination is compression at 105 MPa for 18 min for a dose of 1.25 Mrad. (auth)

**28225** MICROBIOLOGICAL PROBLEMS OF RADIATION STERILIZATION CONTROL OF DISPOSABLE MEDICAL PRODUCTS. Horakova, V. (SVUT Center for Research and Application of Ionizing Radiation, Brno). pp 53-58 of Radiosterilization

of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

Dose-response curves were determined for three strains of cocci and seven strains of aerobic spore-forming rods after irradiation by two different $^{60}Co$ sources and Van de Graaff electron accelerator. Besides the test strains Streptococcus faecium $A_2l$, Bacillus sphaericus $C_1A$ and Bacillus pumilus E 601, some strains isolated from irradiated vaccines and animal diets, or found among common air-contaminating bacteria and pathogenic cocci, were examined. The efficiency of the used radiation sources was compared. The control of the microbiological efficiency of radiation sterilization is discussed regarding routine practice. (auth)

**28226** CHOICE OF THE IRRADIATION DOSE FOR THE STERILIZATION OF MEDICAL PRODUCTS. Bochkarev, V. V.; Pavlov, E. P.; Sedov, V. V.; Khrushchev, V. G.; Tushov, E. G.; Konyaev, G. A. (Inst. of Biophysics of the USSR, Moscow). pp 61-68 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975). (In Russian)

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

The principles for selecting the appropriate dose for the radiation sterilization of medical products are set forth, taking into account the initial contamination of the product, the radiation sensitivity of contaminants and the required level of reliability of sterilization. The initial contamination level of certain medical preparations (glucose and radiopharmaceuticals) is established and the radiation sensitivity of the isolated contaminants is determined in terms of Dio indices. Of the microorganisms isolated the most common were staphylococci, streptococci, Gram-negative bacteria, Aspergilli, Penicillia and yeast fungi. Spore-forming types of microorganisms were isolated with a frequency of the order of $10^{-2}$. The radiation sensitivity in terms of $D_{10}$ was established for more than 3000 strains of microorganisms. For 75-85% of the strains the $D_{10}$ indices gave 10-40 krad and for 0.2-1% more than 100 krad. The experimental data were subjected to computer analysis which confirmed the adequacy of the techniques used to determine radiosensitivity. The authors then calculated by computer the radiation sterilizing doses for different degrees of initial contamination of the products with reliability coefficients of $10^6$ and $10^8$. For sterilizing radiopharmaceuticals and glucose solutions these doses are 0.8-1 Mrad. Verification experiments show that these doses give reliable sterilization of the medical products concerned. (auth)

**28227** RADIOPASTEURIZATION IN THE PROCESSING ON NONSTERILE PHARMACEUTICAL PREPARATIONS AND BASIC MATERIALS. Armbrust, R. F. pp 379-386 of Radiosterilization of Medical Products, 1974. Vienna; International Atomic Energy Agency (Jun 1975).

From symposium on ionizing radiation for sterilization of medical products and biological tissues; Bombay, India (9 Dec 1974). See STI/PUB-383; CONF-741217-.

It is evident that in the near future international and national pharmacopoeia will have requirements on the microbial contamination of non-sterile basic materials and pharmaceutical preparations. As radiopasteurization is a useful method for obtaining the prescribed microbial levels, the necessity for a code of practice for this method is discussed. (auth)

**28228** MITOCHONDRIAL GENETICS. X. Effects of UV Irradiation on Transmission and Recombination of Mitochondrial Genes in Saccharomyces Cerevisiae. Dujon, B.; Kruszewska, A.; Slonimski, P. P.; Bolotin-Fukuhara, M.; Coen, D.; Deutsch, J.; Netter, P.; Weill, L. (Centre National de la Recherche Scientifique, 91-Gif-sur-Yvette (France). Centre de Genetique Moleculaire). Mol. Gen. Genet.; 137: No. 1, 29-72(Apr 1975). 8 figs.; 7 tabs.; 55 refs.

UV irradiation was applied either to one parent prior to crossing or to newly formed zygotes. The effects of UV on the transmission of mitochondrial alleles at the loci conferring resistance to antibiotic and the frequency of recombinants between various combinations of alleles at these loci were studied. The effects depend on the nature of the cross i.e. homosexual ($\omega^+ \times \omega^+$ or $\omega^- \times \omega^-$) or heterosexual ($\omega^+ \times \omega^-$). In all cases UV irradiation of one of the parents diminishes the transmission of the mitochondrial alleles originated from the irradiated parent. In homosexual crosses the decrease of transmission is the same for alleles at all the loci. In heterosexual crosses, when the $\omega^+$ parent is irradiated, there is a differential decrease of transmission depending on the distance of the resistance locus relative to the $\omega$ locus. In heterosexual crosses irradiation of the $\omega^+$ parent increases the frequency of recombinants while irradiation of the $\omega^-$ parent slightly decreases it. In homosexual crosses the frequency of recombinants diminishes when a high UV dose is applied to one of the parents. No or only minor modifications of the polarity of recombination are observed. Irradiation of newly formed zygotes has no or minor effects of the transmission of alleles and recombinant frequencies. All these effects can be interpreted in terms of a general model for recombination of mitochondrial genes. UV ir radiation of one of the parents leads to a modification of the input fraction in favor of the non irradiated parent. As a consequence of this modification the output of alleles and the frequency of recombinants are changed. Relationships between the molecular events responsible for the modifications of input and the production of $\rho^-$ primary clones by UV are discussed. (GE)

**28229** ULTRAVIOLET LIGHT-INDUCED RESPONSES OF AN mfd MUTANT OF E. COLI B/r HAVING A SLOW RATE OF DIMER EXCISION. George, D. L.; Witkin, E. M. (Rutgers - The State Univ., New Brunswick, NJ). Mutat. Res.; 28: 347-354 (1975).

A mutant of Escherichia coli B/r designated mfd has drastically reduced ability to exhibit "mutation frequency decline" (MFD), the irreversible loss of potential suppressor mutations which occurs when protein synthesis is briefly inhibited after irradiation with uv. We have found that the initial rate of thymine dimer excision in the mfd mutant is only about one-third that of its $mfd^+$ parent strain after a uv dose of 400 erg/mm$^2$. The yield of uv-induced $Tyr^+$ revertants is 4 to 10 times higher in the mfd strain than in the $mfd^+$ strain. This is comparable to the level of uv-mutability in the $mfd^+$ strain in the presence of caffeine, an inhibitor of dimer excision. Uv-mutability, prophage induction and Weigle reactivation of irradiated lambda phage occur to a greater extent at low uv doses (10 to 50 erg/mm$^2$) in the mfd strain compared to the $mfd^+$ strain. We propose that the slow excision repair in the mfd mutant results in a shift in the induction threshold for these uv-inducible functions toward lower uv doses. (auth)

## Radiation Effects on Plants

**28230** UBIQUITOUS ATOM. Spruch, G. M.; Spruch, L. (eds.). New York; Charles Scribner's Sons (1974). 462p. $17.50.

The fundamentals of modern physics, including the basic physics and chemistry of the atom, elementary particles, cosmology, periodicity, and recent advances, are surveyed. The biology and chemistry of the life process is discussed to provide a background for considering the effects of atomic particles on living things. The uses of atomic power in space travel, merchant shipping, food preservation, desalination, and nuclear clocks are explored. (Pollut. Abstr.)

**28231** CHROMOSOMAL CHIMERA IN THE GAMMA-IRRADIATED PROGENY OF COLLINSIA HETEROPHYLLA BUIST., SCROPHULARIACEAE (2n = 14). Zaman, M. A.; Rai, K. S. (Univ. of Notre Dame, IN). Bangladesh J. Bot.; 2: No. 1, 77-81(1973).

In the $X_1$ generation C. heterophylla, a few plants showed chromosomal chimeras in the form of (i) diploid and tetraploid branches, (ii) two types of translocation heterozygotes (RTs), and (iii) normal as well as RT-heterozygous branches. In the $X_2$ generation, the chromosomal chimera was restricted to only some aberrant aneuploid or tetraploid PMCs of a few RT-heterozygotes. If the $X_1$ chimeras were due to the direct effect of radiation with the consequent formation of abnormal spindles, the $X_2$ chimeras may be caused by mitotic non-disjunction of one or two chromosomes in some pre-sporocytes just before the onset of meiosis. (auth)

**28232** RADIATION INDUCED MITOTIC DELAY AND STIMULATION OF GROWTH. Feldmann, A. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Entwicklungsbiologie und Biochemie). Stimul. Newsl.; No. 6, 10-16(Dec 1974). 2 figs.; 1 tab.; 6 refs.

The mechanisms responsible for the radiation induced mitotic delay and stimulation of growth are discussed in connection with the results of studies in Lemna minor and Lepidium sativum. The action of temperature seems to be of major importance. As many authors suggest that various chemical agents and slight intoxications also affect mitosis in a way similar to that induced by ionizing radiation, the radiation induced stimulation has lost its specific character and approaches might be found for further investigations of this phenomenon. (GE)

**28233** APPARENT STIMULATION OF VEGETATIVE GROWTH BY ACUTE GAMMA-IRRADIATION IN CROP PLANTS. Davies, C. R. (Wolverhampton Polytechnic (UK). Dept. of Biological Sciences). Stimul. Newsl.; No. 6, 17-23(Dec 1974). 1 fig.; 3 tabs.; 3 refs.

Pot-grown plants were exposed to a wide range of radiation doses from a 5,000 Ci $^{60}$Co γ-source at a dose rate of about 1,800 rads/h at various developmental stages. In spring and winter wheat, spring barley, and spring oat radiation doses of 500 or 1,000 rads during the early vegetation stages caused a significant increase in the number of shoots. In potatoes, peas, and broad beans increases in dry weight were observed in plants irradiated in later stages of life cycle with doses of 500, 1,000, or 2,000 rads. As with cereals, increased vegetative growth was associated with severe reductions in reproductive yield. (GE)

**28234** STIMULATORY EFFECTS OF CHRONIC GAMMA RADIATION ON GROWTH AND DEVELOPMENT OF YOUNG CUSTARD APPLE (ANNONA SQUAMOSA) TREES. Nirale, A. S.; Gaur, B. K. (Bhabha Atomic Research Centre, Bombay (India). Biology and Agriculture Div.). Stimul. Newsl.; No. 6, 24-33 (Dec 1974).

3 figs.; 1 tab.; 10 refs.

Four month old seedlings of custard apple were transplanted in a sector of a Gamma Garden having a 600 Ci $^{60}$Co γ-source in the center. The dose rates were 90-105, 195-240 and 480-640 mR/h. The cumulative doses averaged to 946, 2,064 and 5,300 R. Observations of tree height, trunk thickness and number of branches were performed at regular intervals. During the first fruiting season the number of fallen fruits and the number and weight of edible fruits were recorded. The trees in all 3 radiation zones grew taller than the controls for about 18 months. Radiation-induced greater thickness of the trunk was seen for 27 months, while an increase in the number of branches was observed throughout the experimental period (4 years). As to the fruiting pattern, in spite of the fewer fruits in the irradiated trees they gave higher fruit yield per tree. (GE)

**28235** POLLEN TUBE GROWTH STIMULATION INDUCED BY X-RAY AND UV-LIGHT. Zelles, L. (Gesellschaft fuer Stralen- und Umweltforschung m.b.H., Hannover (F. R. Germany). Inst. fuer Strahlenbotanik). Stimul. Newsl.; No. 6, 42-48(Dec 1974).

2 figs.; 2 tabs.; 9 refs.

Samples of pollen grains (1 mg) were placed on sucrose solution and, after 3 min, irradiated with X-rays or UV-radiation. Afterwards the cultures were illuminated continuously for 3 d by a fluorescence lamp. Actinomycin D causes an inhibition of pollen tube growth by 50%. The effect of low doses of X-rays and UV-irradiation on Actinomycin D treated pollen was studied. In the dark pollen tubes were shorter than in the light even when irradiated with inhibiting doses of UV-radiation. After irradiation with stimulating or inhibiting doses of X-rays the tube length is independent from illumination conditions. Further, a dependence of tube elongation on the dose rate was found. (GE)

**28236** STIMULATING EFFECT OF X- AND γ-RAYS ON THE GROWTH OF THE POLLEN TUBE OF PINUS SILVESTRIS. II. Influence of Dose Rate and Exposure Time. Zelles, L.; Fendrik, I. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Hannover (F. R. Germany). Inst. fuer Strahlenbotanik; Technische Univ. Hannover (F. R. Germany). Inst. fuer Biophysik). Stimul. Newsl.; No. 6, 49-55(Dec 1974).

2 figs.; 9 refs.

As a contribution to the elucidation of the stimulation mechanisms pollen grains of Pinus silvestris were irradiated with various dose rates. The radiation doses varied between 50 and 1,400 rads, the X-ray dose rates between 0.5 and 50 R/sec, the γ-ray dose rates between 0.5 and 40 R/sec. When small doses were delivered at low dose rates a significant enhancement of tube elongation was observed. The same dose at higher dose rates was not effective. To obtain enhanced tube lengths with 300 and 800 rads, dose rates of more than 50 R/sec were necessary. The mechanism responsible for these effects is discussed. Pollen irradiated with a certain dose at low dose rates need longer exposure time than at higher dose rates. It seems that only the first 100 sec are decisive for the stimulatory effect. (GE)

**28237** INFLUENCE OF IONIZING RADIATION ON THE GROWTH OF EARLY RED RADISH. I. Effect of Radiation Applied to Young Plants and Seeds. Fendrik, I. (Technische Univ. Hannover (F. R. Germany). Inst. fuer Biophysik); Bors, J. Stimul. Newsl.; No. 6, 56-60(Dec 1974).

3 refs.; 4 tabs.

Seeds with a moisture content of 12% were exposed to 1,500, 3,000 and 6,000 R of X-rays at a dose rate of 2,000 R/h. The seeds were sown immediately after irradiation or after 24 hrs. The irradiation of the young plants was carried out in the two leaf stage under the same conditions. The following parameters were investigated: fresh weight and dry weight of tuber and leaf, and volume of tubers. The chance to receive stimulation was better in the case of seed irradiation than in the case of plant irradiation. (GE)

**28238** GAMMA RADIATION INDUCED STIMULATION OF GROWTH AND FRUIT YIELD IN CARUM COPTICUM. Khanolkar, S. M.; Khalatkar, A. S.; Dnyansagar, V. R. (Nagpur Univ. (India). Dept. of Botany). Stimul. Newsl.; No. 6, 4-9(Dec 1974).

2 tabs.; 1 ref.

Fruits from a genetically pure stock with 6.6% moisture content were irradiated in the dose range of 5-50 KR in a $^{60}$Co γ-source at a dose rate of 1.1 KR/min. After 12 days the fruits were sown into well prepared fields. The extent of stimulation with γ-rays was determined by studying various parameters like height, number of leaves etc. It was concluded from the results that a positive stimulation in growth and fruit yield can be obtained by irradiation with 5-30 KR of γ-rays. (GE)

**28239** LOW DOSE STIMULATION IN FOENICULUM VULGARE. Jahagirdar, H. A.; Khalatkar, A. W.; Dnyansagar, V. R. (Nagpur Univ. (India). Dept. of Botany). Stimul. Newsl.; No. 6, 1-3(Dec 1974).

1 tab.

Genetically pure seeds with a moisture content of 12.5% were irradiated in a $^{60}$Co γ-source at a dose rate of 1.1 KR/min, the radiation dose varying between 2 and 14 KR. Four days after irradiation the seeds were sown into the open field. Stimulation was determined on the basis of many parameters e.g. height. The results indicated a significant stimulation after 10 KR as far as seed yield is concerned. (GE)

**28240** RADIOBIOLOGICAL IMPLICATIONS OF STATISTICAL VARIATIONS IN ENERGY DEPOSITION BY IONIZING RADIATION. Baily, N. A.; Steigerwalt, J. E. (Univ. of California, San Diego, La Jolla). Adv. Radiat. Biol.; 5: 1-45(1975).

For microdosimetry the entire concept of a relationship between the energy deposited (absorbed dose) and the biological effects observed after irradiation of living tissues by ionizing radiations must be broken down beyond the gross macroscopic approach. This is so because of two facts. First, the size of the site involved is very small, of micrometer dimensions or less (nanometers). Second, indications are that individual sites suffer inactivation leading to cell death due to a single event or very few events. Consequently, the statistics of energy deposition by charged particles in such sites must play an important role in determining the end or observable effect. This review presents a comprehensive picture of the physical processes governing the deposition of energy by charged particles in their passage through matter. Radiobiological data involving measurements of relative biological effectiveness (RBE) are examined on a random basis using these concepts and leading to the use of the most probable energy loss in place of the average energy loss for a determination of absorbed dose. Incorporation of these concepts into current models of radiobiology is illustrated. (70 references) (CH)

**28241** RADIOAKTIVITAET UND UMWELT. (Radioactivity and Environment). Weish, P. (Ludwig Boltzmann-Institut fuer Umweltwissenschaften und Naturschutz, Vienna (Austria)); Gruber, E. (Vienna Univ. (Austria). Analytisches Inst.). Stuttgart; Fischer(1975). 159p.

56 figs.; 15 tabs.; with refs.

The leaflet deals with the natural and man-made sources of radioactivity and their effects on the biosphere as well as, in the last chapter, problems of radiation protection. (GE)

**28242** EFFECT OF DOSE RATE AND EXPOSURE TIME ON THE STIMULATION EFFECT OF TUBE GROWTH OF PINUS SYLVESTRIS POLLEN. Zelles, L.; Fendrik, I. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Hannover (F. R. Germany). Inst. fuer Strahlenbotanik; Technische Univ. Hannover (F. R. Germany). Inst. fuer Biophysik). Radiat. Environ. Biophys.; 12: No. 1, 81-84(Jun 1975).

2 figs.; 11 refs.

The stimulating effect of ionizing radiation in respect to dose rate and exposure time was studied using the tube growth of Pinus silvestris pollen. Stimulation was registered with a small dose (50 rad) supplied at low dose rates (0.5; 1.0; 3.0 and 5.0 rad/sec) and with higher doses (300; 800 and 1,400 rad) supplied at higher dose rates (10; 40 and 50 rad/sec). This suggests that only the exposure time is of importance for radiation-induced stimulation provided that the exposure time does not exceed 100 sec. (GE)

**28243** FURTHER EVIDENCE FOR UNCOUPLING ACTION OF GAMMA RADIATION IN EXCISED BEAM HYPOCOTYL SEGMENTS. Gaur, B. K.; Joshi, V. G. (Bhabha Atomic Research Centre, Bombay (India). Biology and Agriculture Div.). Z. Pflanzenphysiol.; 74: 219-225(1975).

5 figs.; 18 refs.

That ionizing radiations act as uncoupler of oxidative phosphorylation in animal tissue has been well documented in the literature. The report supports an earlier suggestion for a similar behavior of gamma radiation in plant system. Mitochondria were extracted from normal and gamma-irradiated hypocotyl segments of 4-day old bean seedlings. Swelling and contraction were initiated by supplying suitable substrates. The changes in turbidity were then recorded spectrophotometrically in the presence and absence of 2,4-dinitrophenol (DNP). Radiation enhanced the swelling per se as well as its rate. The contraction, on the other hand, was markedly reduced. While the effect of DNP alone was qualitatively similar to that of radiation, it was lowered in the pre-irradiated tissue. These observations are discussed in the light of known/proposed mechanisms of action of the classical uncoupler DNP. (GE)

# Radiation Effects on Animals

*Refer also to abstracts 28240, 28241, and 28976.*

## Man

*Refer also to abstracts 27950, 28180, 28771, 28993, 29183, 29989, 29992, and 30348.*

**28244** (APR-38) RADIATION DOSE REDUCTION FOR PATIENTS IN DIAGNOSTIC RADIOLOGY. Nave, M. (Ministry of Health, Jerusalem (Israel). Div. for Air Pollution and Radiation Control; Technion-Israel Inst. of Tech., Haifa. Faculty of Civil Engineering). Feb 1973. 115p. (In Hebrew). INIS.

Diagnostic radiology constitutes one of the major sources of population exposure to ionizing radiation. In the present study, the possibility of reducing the patient radiation dose throughout x-ray examinations by means of changes in various physical parameters was investigated. The procedures: Chest PA, Abdomen AP and Lumbosacral L were studied, while various physical parameters, namely high voltage, added filtration, grid ratio and intensifying screen speed were routinely varied. Skin dose, transmitted dose and gonad dose were measured on a phantom. A total of a thousand exposures was performed. In addition, a few hundred actual exposures of various x-ray films were made. "Optimal pictures" for each combination of exposure conditions were selected and the skin dose, transmission ratio, and gonadal dose obtained were calculated. It was found that it is possible to reduce the skin dose by factors of 2.8 and 9.6 (for chest and abdomen radiographs respectively) by adding 2 mm aluminium plus 0.2 mm copper filters to the tube and increasing the voltage from 70 to 145 KV. Identical addition of filtration while increasing the voltage from 85 to 145 KV resulted, in the case of Lumbosacral radiographs, in dose reduction by a factor of 5.3. Simultaneous reduction in the gonad dose was observed (by factors of 3.5 (ovary dose) and 4.6 (testes dose) in the case of abdomen radiographs). By replacing the "high energy grid" with "medium energy grid", reduction of skin dose by factors of between 1.0–1.6 was measured (dependent upon voltage and filtration). The replacement of the Universal intensifying screen by a high speed one was followed by skin dose reduction between 1.3–1.7. Change of the parameters in order to reduce the patient exposure dose results in reduction of the picture quality. For various diagnostic procedures, pictures of varying quality are required even if the examined organ is identical. The roentgenologist has to take into consideration this fact and to determine, prior to the accomplishment of each exposure, what is the picture quality desired for the specific case. According to that specific decision, it is possible to fix the various parameters in order to result in an optimal exposure. (auth)

**28245** (FOA-C-40003-A3) EVALUATION OF THE BIOLOGICAL EFFECTS OF SMALL DOSES OF IONIZING RADIATION. Extrapolation of the Dose-Effect Relation. Rydberg, B. (Foersvarets Forskningsanstalt, Stockholm (Sweden)). Sep 1974. 18p. (In Swedish). Dep. NTIS (US Sales Only) $4.00.

A short description is given of the experimental and theoretical background of extrapolation of biological effects of ionizing radiation to small doses. Experimentally measured data on dose-effect-relationships for induction of cancer and genetic effects are described. Known facts about the mechanisms important for induction of cancer and mutations with ionizing radiation are surveyed. (auth)

**28246** (INIS-mf-1628, pp 77) DOSIMETRIC PROBLEMS OF THE IRRADIATION OF MALIGNANT TUMORS OF THE NASAL AND PARANASAL CAVITIES WITH ACCELERATED ELECTRONS. Ganchev, M.; Pandova, V. 1973. (In Bulgarian).

From 3rd international conference on radiology and radiobiology; Plovdiv, Bulgaria (1 Nov 1973).

Published in summary form only. Abstract available in English.

In third national conference on radiology and radiobiology. Abstracts. (Ministerstvo na Narodnoto Zdrave, Sofia (Bulgaria); Meditsinska Akademiya, Sofia (Bulgaria); Nauchno Druzhestvo na Rentgenolozite i Radiolozite, Sofia (Bulgaria). Sektsiya po Radiologiya).

An essential problem in the radiation treatment of tumors of the nasal and paranasal cavities is the considerable unevenness of the entrance surface and the "protection" of the eyeballs situated in close proximity to these cavities. Detailed dosimetric studies have shown that irradiation ought to be done through individual levelling moulage of Columbian paste. Regarding the interaction with accelerated electrons, the properties of Columbian paste are closest to the soft tissues of the human body. As to the eyeball "protection" it will be necessary to incorporate in the levelling moulage lead screens having variable thickness depending on the initial energy of the electron beam. The choice of the size of the entrance area should take into consideration the influence of the lead screens on the dose field. (auth)

**28247** (ORNL-5055) APPLIED HEALTH PHYSICS AND SAFETY ANNUAL REPORT FOR 1974. Progress Report, 1974. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 69p. Dep. NTIS $5.45.

Activities of the Health Physics Division are described and summarized. Work is in progress on radiation monitoring, radiation safety, industrial safety, and environmental surveillance. Separate abstracts were prepared for four sections of the report. (SFL)

*For abstracts of individual sections see: 27913, 27949, 27950, and 28248.*

**28248** (ORNL-5055, pp 3-17) RADIATION MONITORING. Aug 1975.

In applied health physics and safety annual report for 1974. Progress report, 1974. (Oak Ridge National Lab., Tenn. (USA)).

There were no external or internal exposures to personnel of ORNL which exceeded the standards for radiation protection as defined in ERDA Manual Chapter 0524. Only 41 employees received exposures greater than 1 rem. The highest whole-body exposure dose equivalent to an employee was 3.58 rem. The highest internal exposure was less than one-half of the maximum permissible body burden. During 1974, 20 portable instruments were added to the inventory and nine retired. The total number in service on January 1, 1975, was 1,294. There were 22 facility radiation monitoring instruments installed and 21 retired during 1974. The total number in service on January 1, 1975, was 983. (auth)

**28249** (SAAS-177) RECOMMENDATIONS FOR DEVELOPMENT OF PLANS FOR FIRST AID TREATMENT FOLLOWING RADIATION ACCIDENTS. Schuettmann, W. (Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)). May 1975. 26p. (In German). Dep. NTIS (US Sales Only) $4.50.

The report deals with preparation and implementation of first aid depending upon the different types of radiation accidents. First aid is to be implemented according to a schedule being part of the emergency plan. To provide guidance in the development of such a schedule, a specimen plan is given in the addendum. (auth)

**28250** (SRL-75001) PREPARATION OF IMPLANT TUBES FOR INTERSTITIAL AFTERLOADING OF $^{252}Cf$ SEED ASSEMBLIES. Permar, P. H.; Walker, V. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Sep 1975. 8p. Dep. NTIS $4.00.

As part of its $^{252}Cf$ Market Evaluation Program, the Energy Research and Development Administration provides $^{252}Cf$ neutron sources to medical institutions for the evaluation of $^{252}Cf$ in cancer therapy. A $^{252}Cf$ interstitial implant system that resembles the $^{192}Ir$ system was developed at the Savannah River Laboratory. This document describes the preparation of implant tubes using equipment and materials supplied by the Savannah River Laboratory under the ERDA program for evaluation of $^{252}Cf$ medical neutron sources. The interstitial implant system is described in SRL-74-004, and the butt-welding of Tefzel (trademark of E. I. du Pont de Nemours and Co.) leaders to $^{252}Cf$ seed assemblies is described in SRL-74-002. An alternative implant tube using commercially available pre-sterilized catheter needles is also described in this document. (auth)

**28251** (SSI-1974-031) BIOLOGICAL RISKS FROM DENTAL X RAYS. Bengtsson, G. (Statens Straalskyddsinstitut, Stockholm (Sweden)). Nov 1974. 6p. (In Swedish). Dep. NTIS (US Sales Only) $4.00.

Risks that might be connected with the use of x-ray examination of teeth are reviewed. A brief survey is given of the effects of ionizing radiation on cells. Consequences of cell damage are de-

scribed, especially neoplasms, leukemia, and genetic effects. The correlation between radiation dose and risk is noted. (auth)

**28252** RISK OF LEUKEMIA IN SUSCEPTIBLE CHILDREN EXPOSED TO PRECONCEPTION, IN UTERO, AND POSTNATAL RADIATION. Bross, I. D. J.; Natarajan, N. (Roswell Park Memorial Inst., Buffalo). Prev. Med.; 3: No. 3, 361-369(1974).

Further statistical analysis has clarified the hypothesis that there exists a susceptible subgroup of children who are prone to develop leukemia after exposure to low doses of diagnostic radiation which have no effect on normal insusceptible children. The susceptible group does not show marked increase in relative risk when there is no report of exposure. The risk of developing leukemia among the susceptible children with any of the three types of radiation exposure is markedly increased in the appropriate age groups. The data are concordant with a latent period of 4 to 7 years. (auth)

**28253** RADIOTHERAPY OF CANCER OF THE CERVIX. Taggart, C. H. (Good Samaritan Hospital, Phoenix, AZ). Ariz. Med.; 32: No. 1, 34-36(Jan 1975).

This new section in Arizona Medicine is specifically targeted to the subject of cancer care in the state of Arizona. Recognition of the importance of cancer management has been underscored by the establishment of the conquest of cancer as a national goal. In this column, current concepts in cancer management and recent advances in cancer research that are relevant to Arizona will be discussed each month. Cancer therapy is currently changing at an extraordinarily rapid rate, and the views expressed on this page should not be considered as static recommendations. The editors of this column will select key topics and invite interested physicians and allied health professionals from Arizona to write components related to areas of their expertise in cancer. (auth)

**28254** ORAL AND DENTAL CARE FOR THE IRRADIATED PATIENT. Carl, W. (Roswell Park Memorial Inst., Buffalo). Quintessence Int.; 5: No. 10, 55-62(Oct 1974).

Close cooperation between physician, dentist, and patient is essential in the oral care after irradiation for cancer of the head and neck. Meticulous oral hygiene, topical fluoride application, irrigation, and lubrication of the oral cavity help control radiation decay and other complications from radiation therapy. Conservative and conventional dental restorative procedures and materials are most practical. The best time for prosthetic work seems to be after the acute signs of radiation exposure have subsided. The effects of radiation are irreversible and persist for the life of the patient. Constant supervision of the irradiated patient is essential for his welfare. (auth)

**28255** DIETARY PROTECTION DURING RADIATION THERAPY. Bounous, G.; Le Bel, E.; Shuster, J.; Gold, P.; Tahan, W. T.; Bastin, E. (Centre Hospitalier Universitaire de Sherbrooke (Canada). Dept. of Surgery; Centre Hospitalier Universitaire de Sherbrooke (Canada). Dept. of Nuclear Medicine; Montreal General Hospital, Quebec (Canada). Div. of Clinical Immunology and Allergy). Strahlentherapie; 149: No. 5, 476-483 (May 1975).

Eighteen patients receiving Cobalt 60 irradiation for abdominal or pelvic malignancies were assigned at random to eat either a semi-hydrolyzed diet (Flexical: 10 g% casein hydrolsate; 14 g% triglycerides, 20% of which had medium chain; and 66% disaccharides) or a normal diet. There were no significant differences between these two groups with respect to age and the ratio of ideal to actual caloric intake. The patients in the control group received on the average a total of 3,900 rd and those in the Flexical group 4,040 rd. Generally, Flexical appeared to have a significant positive effect on body weight. In addition, radiation-induced diarrhea was not a problem in the Flexical group. In the latter-group, serum proteins including immunoglobulins remained essentially unchanged during therapy while a moderate but significant fall was observed in all control patients. No significant difference between the two groups was observed with respect to peripheral blood hematocrit, red and white cell counts. However, the drop in blood lymphocytes following irradiation was significantly less in the Flexical group. The mechanisms of radioprotection are discussed. These preliminary data indicate that the nutritional and perhaps the immunological status of cancer patients receiving intensive irradiation can be maintained by dietary measures. (GE)

**28256** RADIATION-INDUCED CHROMOSOMAL ABERRATIONS IN HUMAN LYMPHOCYTES AFTER PARTIAL-BODY EXPOSURE TO $^{60}$Co GAMMA IRRADIATION AND IN VITRO EXPOSURE TO 230 kV X-IRRADIATION. Watson, G. E.; Gillies, N. E. (Middlesex Hospital, London). Br. J. Radiol.; 48: No. 570, 487-493(Jun 1975).

Small yields of chromosome aberrations were present in lymphocytes from 12 patients observed at first metaphase in culture. Blood samples were obtained at various times, up to three days, after single partial-body therapeutic exposure ranging from 75 to 400 rads of $^{60}$Co $\gamma$ irradiation. When all patients were considered there was no correlation between treatment dose and aberration frequency, but no subdivision into two groups on the basis of whether the reticuloendothelial system was involved in the cancer, linear regression analysis could be fitted to the data for each group. An in vitro dose response curve for dicentrics induced by 230 kV x rays at a dose rate of 23.3 rads per minute was constructed for use as a standard calibration curve for 48 hour cultures. The yield of dicentric aberrations was best fitted by a power law model, $Y = kD^n$ in which $k = (1.59 \pm 0.66)\ 10^{-4}$ and $n = 1.49 \pm 0.08$, ($P = 0.96$). (auth)

**28257** LYMPHOCYTE RESPONSE TO PHYTOHAEMAGGLUTININ AFTER IN VITRO IRRADIATION. Song, C. W.; Levitt, S. H. (Univ. of Minnesota, Minneapolis). Br. J. Radiol.; 48: No. 570, 504(Jun 1975).

The response of irradiated human lymphocytes to phytohaemagglutinin (PHA) has been investigated by a number of authors. Braeman and Moore (Braeman, J., and Moore, J. L., 1974, Br. J. Radiol., 47, 297) observed a marked effect of irradiation on the morphological transformation of lymphocytes, but their results differed from those reported in a number of other studies. The ability of lymphocytes to transform to blast cells following PHA stimulation is usually far less vulnerable to radiation than Braeman and Moore reported. These authors compared the PHA response of lymphocytes irradiated in vitro with a single dose to that of lymphocytes of blood obtained from patients who had received a number of fractionated irradiations. Injured lymphocytes are removed promptly from circulation, and these patients' blood would not therefore be expected to contain any significant number of radiation damaged lymphocytes. The difference from lymphocytes irradiated with a single dose in vitro would be greater than Braeman and Moore anticipated. The decrease in PHA response of lymphocytes from cancer patients who had received radiotherapy could have been primarily the result of other factors such as a depression in proportion of thymus-derived lymphocytes (T-cells), while the decline in PHA response of lymphocytes in blood irradiated in vitro was the result of damage to the T-cells. (UK)

**28258** CONTINUING OCCURRENCE OF THYROID CARCINOMA AFTER IRRADIATION TO THE NECK IN INFANCY AND CHILDHOOD. Refetoff, S.; Harrison, J.; Karanfilski, B. T.; Kaplan, E. L.; De Groot, L. J.; Bekerman, C. (Univ. of Chicago). New Engl. J. Med.; 292: No. 4, 171-175(23 Jan 1975).

To determine whether the occurrence of x-ray-induced thyroid carcinoma has not declined, we examined 100 patients with a history of irradiation to the neck area. Irradiation had been given to tonsils (42 percent), adenoids (10 percent), tonsils and adenoids (7 percent) and thymus (30 percent), for acne (7 percent), and for various other reasons (7 percent). Operation was recommended to 18 of 26 patients with palpable abnormalities and 15 were operated upon; we found seven carcinomas, and eight benign lesions. Five of six carcinomas had invasive characteristics, with or without metastases, five of seven were multifocal, and six of seven had a follicular component. Of seven patients irradiated to both tonsils and adenoids and thus receiving higher radiation exposure, two had carcinoma, suggesting a dose relation. The overall 7 percent prevalence of carcinoma in unselected patients with a history of irradiation to the neck area is higher than expected and implies a continuing important public-health problem, at least in the Chicago area. (auth)

**28259** PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CANCER CONGRESS. Volume I. Cell Biology and Tumor Immunology. Conference Held at Florence, Italy, October 20–26, 1974. Bucalossi, P.; Veronesi, U.; Cascinelli, N. (eds.). International Congress Series Number 349. Amsterdam; Excerpta Medica(1975). vp.

Separate abstracts were prepared for four of the papers presented in this symposium. (ERB)

*For abstracts of individual papers see: 28180, 28201, 28202, and 28260.*

**28260** EXCISION REPAIR IN HUMAN CELLS. Bootsma, D.; de Weerd-Kastelein, E. A. (Erasmu Univ., Rotterdam, Netherlands). pp 164-169 of Cell Biology and Tumor Immunology. Vol. I. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

The nature of the DNA damage produced by ionizing radiation is chemically very similar in prokaryotic and eukaryotic cells. It is likely that also the enzymatic repair that follows is chemically very similar. (NL)

**28261** PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CANCER CONGRESS. Volume V. Surgery, Radiotherapy and Chemotherapy of Cancer. Conference Held at Florence, Italy, October 20–26, 1974. Bucalossi, P.; Veronesi, U.; Cascinelli, N. (eds.). International Congress Series, Number 353. Amsterdam; Excerpta Medica(1975). vp.

Separate abstracts were prepared for 16 of the papers presented in this volume of the proceedings. (ERB)

*For abstracts of individual papers see: 28181–28185 and 28262–28272.*

**28262** MORPHOLOGICAL AND FUNCTIONAL EFFECTS OF LOCAL LYMPH NODE IRRADIATION. Engeset, A. (Norske Radiumhospital, Oslo). pp 21-25 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Local lymph node irradiation with cancericide doses is followed by acute and chronic regressive alterations of the irradiated nodes and acute as well as protracted lymphocytopenia of the blood. The morphological alterations of the lymph nodes as studied in animal experiments can be classified into three distinct phases: an early phase distinguished by cell destruction, an intermediate phase during which repopulation occurs, and a late phase characterized by regressive alterations. Timing and dose dependence of the effects in the three phases are described as well as the functional response. The fall in B and T lymphocytes with radiation-induced lymphocytopenia is discussed. The clinical implications are then considered. (NL)

**28263** ELECTRON-AFFINIC SENSITIZERS FOR HYPOXIC CELLS. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.). pp 83-90 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Many chemical compounds are known that can act as radiosensitizers. They are only of clinical value if their effects in normal and in malignant tissues are different. Radiosensitizers belonging to the electron-affinic group may be applied; these are active only against hypoxic cells. (NL)

**28264** INHIBITION OF DNA REPAIR PROCESSES. Smith, K. C. (Stanford Univ., CA). pp 105-110 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Cells can be sensitized to radiation by three major mechanisms: the efficiency of the initial radiobiological effect can be increased by electron-affinic compounds and sulfhydryl-binding agents; the radiation sensitivity of DNA can be increased by analog substitution as the replacement of thymine by 5-bromouracil; the repair of radiation-induced damage to DNA can be inhibited by chemicals. The optimum approach to the successful destruction of tumor cells with radiation plus sensitizers will depend upon the use of radiation potentiating agents plus repair inhibitors. (NL)

**28265** STUDY OF RADIATION AND HEAT EFFECTS DURING THE MAMMALIAN CELL CYCLE. Dewey, W. C.; Gerweck, L. E.; Carver, J.; Gillette, E. L.; Thrall, D. E. (Colorado State Univ., Fort Collins). pp 111-121 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

X-ray induced cell lethality results from chromosomal aberrations which are more readily produced during the radiosensitive mitotic phase than during the radioresistant S-phase. When heat is administered prior to irradiation, the variation in radiosensitivity normally seen between G1 and S is eliminated. These changes cannot be explained in terms of damage to DNA as measured by single-strand breaks or the frequency of mutant cells. A model is presented in which lesions in DNA can either be repaired or fixed by interacting with each other. Following irradiation, the probability of interaction (fixation) increases and the repair decreases when chromatin is condensed either during mitosis or by treatment with a hypertonic medium when cells are preheated and when cells are heated in early S-phase. Heat treatment might be of value in radiotherapy. (NL)

**28266** OXYGEN EFFECT AND REOXYGENATION. Kallman, R. F. (Stanford Univ., CA). pp 136-140 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A review is given of theories and experiments dealing with the phenomenon that anoxic cells might become oxygenated as a result of radiation. By applying fractionated irradiation, the radiation effect on the radiation-induced oxygenated cells can be increased. Understanding this phenomenon may lead to a better treatment planning in radiotherapy. (NL)

**28267** REPOPULATION OF NORMAL AND NEOPLASTIC TISSUE AFTER X IRRADIATION. Malaise, E. P. (Institut Gustare Roussy, Villejuif, France). pp 141-148 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A review is given of the effects of fractionated x irradiation upon cell proliferation both in normal tissue and in tumors. Applications of the results in radiotherapeutical treatment are discussed. (NL)

**28268** FACTORS INFLUENCING THE RESULTS OF TREATMENT WITH FAST NEUTRONS FROM THE MEDICAL RESEARCH COUNCIL'S CYCLOTRON AT HAMMERSMITH HOSPITAL, LONDON. Catterall, M. (Hammersmith Hospital, London). pp 149-153 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A presentation is given of results obtained after radiotherapeutic treatment of patients with different neoplasms with fast neutrons from the MRC cyclotron in the London Hammersmith Hospital. Remarkably complete regression of all tumors including those usually classed as radioresistant had been observed. (NL)

**28269** QUANTITATIVE ASPECTS OF RBE AND OER VALUES FOR EFFECTS ON TUMORS AND NORMAL TISSUES. Field, S. B.; Hornsey, S. (Hammersmith Hospital, London). pp 154-160 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

For any tissue, the RBE for fast neutrons varies with the dose per fraction consistent with the different shapes of cell survival curves after high or low LET irradiation. Using neutrons produced by 16.MeV deuterons on beryllium, RBE as a function of dose per fraction was measured for skin reactions in mouse, rat, pig, and man. The results were the same for all four species but it is not known whether this holds true for all tissues. A graph of RBE curves is given for skin, gut, esophagus, cartilage, lung, and hemopoietic tissues and a considerable variation from tissue to tissue is demonstrated. The RBE for single doses to tumors differs among the tumors but is higher than for most other tissues. For multi-fractionated treatment, there is a general reduction in RBE for tumors, probably due to reoxygenation between fractions. The RBE for a particular tumor cannot be predicted. (NL)

**28270** PIONS AND HEAVY IONS IN RADIOTHERAPY: A BRIEF REVIEW. Raju, M. R. (Los Alamos Scientific Lab., NM). pp 161-167 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A brief review is given of the possibilities and the limiting factors in the application of negative pions and heavy ions in radiotherapy. The use of these species might provide improved radiotherapeutic treatment of tumors. (NL)

**28271** RADIOBIOLOGICAL AND PHYSICAL CHARACTERISTICS OF FAST NEUTRON BEAMS. Broerse, J. J.; Barendsen, G. W. (Gezondheidsorganisatie TNO, Rijswijk, Netherlands). pp 168-173 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Some of the physical characteristics of fast neutron beams as transverse dose distribution and central axis distribution produced by neutron beams and obtained from various sources are outlined. Also, problems with respect to technical features are discussed. (NL)

**28272** CLINICAL TRIALS ON FRACTIONATION. Dutreix, J.; Rubinstein-Zummer, K.; Hesse, C. (Institut Gustave Roussy,

Villejuif, France). pp 187-193 of Proceedings of the Eleventh International Cancer Congress. Vol. V. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica(1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A summary is given of clinical trials undertaken to establish the optimum schedule for radiotherapeutic treatment of epitheliomas. An optimization of the fractionation scheme as opposed to the conventional fractionated irradiation programs may best be achieved by international cooperation and control. (NL)

**28273** EFFECT OF DEXAMETHASON ON THE FORMATION OF INTESTINAL ADHESIONS AS A CONSECUTIVE SYMPTOM OF POSTOPERATIVE IRRADIATION. Tanaka, Y.; Fujiwara, T.; Hayashi, T.; Exumi, K. (Tenri Hospital, Nara (Japan)). Strahlentherapie; 149: No. 6, 608-620(Jun 1975). (In German).

7 figs.; 4 tabs.; 25 refs.

In order to study the effect of postoperative irradiation by means of a 6 MeV linear accelerator on intestinal adhesions and fibrosis and also determine the effects of DM on these processes, experiments were carried out on 76 rabbits. When irradiation alone was conducted without any operative procedure, neither thickening of the intestinal canal, serosa, nor adhesions occurred immediately after irradiation. One week after postoperative irradiation, no effect of irradiation was noted on the intestine or the surgically induced adhesion. Several months later, however, collagenization of the site of the adhesion was seen. At this time, inflammation still persisted, so that further intensification of the adhesions remains a possibility. DM definitely prevented intestinal adhesions secondary to surgery due to operation. It is also evident that this substance inhibits intestinal adhesions and collagenization induced by combined surgery and irradiation. (GE)

**28274** STUDY CONCERNING THE LATE REACTION OF URINARY BLADDER FOLLOWING IRRADIATION OF THE CARCINOMA OF THE CERVIX. Kuemper, H. J.; Michailov, M. C.; Penning, W.; Goetz, A. (Muenchen Univ. (F. R. Germany). 2. Frauenklinik; Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (F.R. Germany). Inst. fuer Biologie). Strahlentherapie; 149: No. 6, 602-607(Jun 1975). (In German).

The study presents the cystotonometric checks of trends in 102 patients with irradiated carcinoma of the cervix up to the time of the so-called five-year survival recovery. As compared with a standard control group concerning the function of the urinary bladder, a distinct tendency to hypertonia is realized and attributed as inevitable to radiotherapy. The moderate load being present before the onset of irradiation is mentioned, resulting from diagnostic operations and from the primary disease. Based on these observations, functional findings which allow objectivation appear to be indicated, the aim being to recognize, as early as possible, the increase of vesical reactions with regard to gynecological radiotherapy and later follow-up care. (GE)

**28275** ADVANCES IN RADIATION BIOLOGY. Volume V. Lett, J. T.; Adler, H. New York; Acs lemic Press (1975). 277p.

Separate abstracts were written for five of the chapters. Five were included in Nuclear Science Abstracts, and four were included in ERDA Research Abstracts. (CH)

*For abstracts of individual chapters see: 28186, 28240, 28299, 28300, and 30374.*

**28276** PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CANCER CONGRESS. Volume III. Cancer Epidemiology, Environmentals Factors. Conference Held at Florence, Italy, October 20-26, 1974. Bucalossi, P.; Veronesi, U.; Cascinelli, N. (eds.). International Congress Series Number 351. Amsterdam; Excerpta Medica (1975). vp.

Separate abstracts were prepared for five of the papers presented in this volume of the proceedings. (ERB)

*For abstracts of individual papers see: 28277-28281.*

**28277** NEOPLASIAS AMONG THE ATOMIC BOMB SURVIVORS IN JAPAN. Watanabe, S. (National Cancer Center, Tokyo). pp 19-75 of Proceedings of the Eleventh International Cancer Congress. Vol. III. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A significant increase in thyroid carcinoma among survivors of the atomic bomb explosion in Hiroshima has been observed. An increase is also found in the incidence of salivary gland tumors and breast tumors. A tendency that lung and stomach carcinoma incidence increased as well is observed. (NL)

**28278** MORTALITY OF AMERICAN INDIAN URANIUM MINERS. Wagner, J. K.; Archer, V. E.; Gillam, J. D. (Dept. of Health, Education, and Welfare, Cincinnati). pp 102-107 of Cell Biology and Tumor Immunology. Vol. III. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

The frequency of respiratory cancer among practically non-smoking American Indians working in uranium mines was found to be increased significantly. There is no evidence for the hypothesis that because of the absence of smoking, a factor in carcinogenesis, non-smoking workers in uranium mines may be exposed to higher radiation doses than their smoking colleagues. (NL)

**28279** INHIBITORY EFFECT OF CAFFEINE ON THE INDUCTION OF CUTANEOUS TUMORS IN MICE BY ULTRAVIOLET RAYS. Zajdela, F.; Latarjet, R. (Institut National de la Sante et de la Recherche Medicale (INSERM), Orsay, France). pp 120-124 of Proceedings of the Eleventh International Cancer Congress. Vol. III. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

Caffeine, a substance known to inhibit the repair of photolesions in nucleic acids, reduced to about half the incidence of cutaneous tumors produced by ultraviolet rays in the mouse. This implies a caffeine effect on almost all the target cells of the epidermis, each one capable of initiating a tumoral process. This result is in favor of the idea that carcinogenesis by ultraviolet radiation is triggered by a DNA repair mechanism that, while permitting the cell to survive, leaves a particular error in the DNA and even favors its production. (NL)

**28280** IONIZING RADIATION EXPERIMENTAL; RADIATION CARCINOGENESIS IN VITRO. Klein, J. C. (Gezondhiidsorganisatie TNO, Rijswijk, Netherland). pp 125-130 of Proceedings of the Eleventh International Cancer Congress. Vol. III. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

In vitro studies on radiation-induced carcinogenesis in animal tissue cultures offer the possibility to investigate malignant transformation directly on a cellular base and to exclude complicating factors that operate in whole animals. Quantitative data can be provided within a reasonable amount of time and at low cost. Results imply that mitotic active cells are viable with respect to carcinogenesis and that the presence of damaged cells and cell debris have a stimulating effect on radiation carcinogenesis. (NL)

**28281** ENVIRONMENTAL FACTORS IN CANCER REDUCTION; APPRAISAL OF EPIDEMIOLOGIC EVIDENCE LEUKEMIA, LYMPHOMA, AND RADIATION. Jablon, S. (National Research Council, Washington, DC). pp 239-243 of Proceedings of the Eleventh International Cancer Congress. Vol. III. Bucalossi, P. (ed.). Amsterdam; Excerpta Medica (1975).

From 11th international cancer congress; Florence, Italy (20 Oct 1974).

A number of pieces of evidence point to the double-strand DNA break as being the radiation-produced lesion which leads to radiogenic leukemia. The relative efficacy of gamma rays and neutrons in producing double-strand breaks leads to the inference that the response curve for gamma rays should be second degree and for neutrons first degree. Such a model fits the data on leukemia mortality among the Japanese A-bomb survivors better than a model linear for both kinds of radiation. The ratio of the numerical coefficients of the neutron and gamma ray terms is close to that reported for a number of effects in dissimilar biological systems. (NL)

**28282** DISPUTE OVER SAFE USES OF X RAYS IN MEDICAL PRACTICE. Nader, C. (Smithsonian Institution, Washington, DC). Health Phys.; 29: No. 1, 181-206(Jul 1975).

Human exposure to medical diagnostic x rays can be reduced by 90% without loss of benefit. Scientific evidence of damaging biological effects indicates it should be reduced, and health physicists have a major professional and ethical role to play in reducing potentially harmful exposure. However, unnecessary and avoidable exposure persists as the rate of use of x rays increases, about 2% annually since 1964. Solutions to this problem are available through policies to ensure improved equipment, qualified operators, medical and dental professionals who are knowledgeable about radiation protection principles, and mandatory performance standards and enforcement mechanisms. The long-standing medical stewardship over diagnostic x rays in these areas is found wanting. Resistance by the medical and dental professions to corrective actions, the drive by critics, including

health physicists, for public accountability in medical x ray uses, and the non-administration of the Radiation Control for Health and Safety Act of 1968 by officials of the Department of Health Education and Welfare are examined. Programmatic recommendations to strengthen the law and its administration are suggested. (auth)

**28283** INTERNAL DOSE CALCULATIONS AND MEASUREMENTS. Feher, I.; Koblinger, L.; Szabo, P. P. (Central Research Inst. for Physics, Budapest). Health Phys.; 29: No. 1, 107-109(Jul 1975).

Energies absorbed in thyroid and testicles due to $^{60}Co$ and $^{131}I$ sources in the lungs are calculated and measured for a modified BOMAB phantom. Results obtained by Monte Carlo calculations and measurements carried out with LiF TL powder suspended in an organic vehicle are in agreement. The measurements are repeated using the $^{60}Co$ source after exchanging the source and target organs. Comparison of the two sets of results shows that the theory of reciprocity can be used for approximate determination of organ doses. (auth)

**28284** BONE MARROW DAMAGE DUE TO ACUTE AND CHRONIC RADIATION EFFECTS. Burkhardt, R.; Beil, E. (Muenchen Univ. (F. R. Germany). Abt. fuer Klinische Knochenmarksdiagnostik; Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Muenchen (F. R. Germany). Abt. Haematomorphologie). pp 73-87 of Strahlen, blutgerinnung, und haemostase. Marx, R. (ed.). Stuttgart; Schattauer(1974). (In German).

From 16th Hamburg symposium on blood clotting; Hamburg, F. R. Germany(1 Jun 1973). 15 figs.; 1 tab.; 15 refs.

Long-term observations on polycythemia patients who had been treated several times with radiophosphorus show that the only light-microscopically detectable consequence of the radiation treatment probably consists in a depletion of the bone marrow of arterial capillaries. This capillary depletion is possibly a general characteristic of the chronic structural radiation damage of the bone marrow. Histobioptic observations of the course of the changes occurring at the iliac crest during gynecological tumour irradiation show serious changes lasting at least 3 months in the bone marrow as well as in the medullary flow and the bone. Although the damaged medullary regions are surrounded by intact bone marrow, a general regeneration of the infarct-similar damages only starts after about 3 months. There are 3 types of courses of regeneration: a plasmocellular edematous type, a lymphocytic sclerosing and a histiocytic regenerating type. The kind of the local bone marrow damage probably influences the prognosis of the resettling. The rarity of thromboses, in spite of serious vascular damage and stasis, suggests the dominance of thrombolytic procedures in the irradiated region. (GE)

**28285** INTERNAL DOSIMETRY OF SPONTANEOUSLY FISSIONING NUCLIDES. Dillman, L. T.; Jones, T. D. (Oak Ridge National Lab., TN). Health Phys.; 29: No. 1, 111-123(Jul 1975).

A general method has been developed which allows one to estimate the radiation dose to various organs of a homogeneous reference man phantom for the case of internally deposited spontaneously fissioning nuclides. Spontaneously fissioning nuclides are bone seekers but the GI tract, lungs, liver and genetic organs are also considered in this study. The doses due to neutrons, prompt and delayed gamma rays, beta particles, and recoil fragments are each considered separately. The known calculated neutron dose distribution about a point-isotropic $^{252}Cf$ source is used to obtain the average dose, by Monte Carlo techniques, to any organ for the source uniformly distributed in a specified organ. The prompt and delayed gamma spectra associated with the fission of $^{238}U$ are used in conjunction with known specific absorbed fractions in order to obtain dose estimates. The fission of $^{236}U$ is also used as a prototype for beta dosimetry calculations. For neutron, gamma, and beta radiation, methods are discussed which allow one to obtain corresponding results for any spontaneously fissioning nuclide. (auth)

## Vertebrates

*Refer also to abstracts 28177, 28183, 28215, and 28269.*

**28286** (ORO-4812-1) EFFECTS OF IONIZING RADIATION ON THE MAMMALIAN LENS. Progress report, 1 October 1974–30 September 1975. Cleary, S. F. (Virginia Commonwealth Univ., Richmond (USA)). 1975. Contract AT(40-1)-4812. 4p. Dep. NTIS $4.00.

Progress is reported on a study of ocular pathology in rhesus monkeys following exposure of the eyes to various doses of 100 MeV protons or 1 MeV x radiation. (CH)

**28287** STUDIES ABOUT THE ENZYME ACTIVITY CHANGES OF THE SKIN CAUSED BY X-RAYS. II. Acid Phosphatasis, Alkaline Phosphatasis. Bathori, E.; Soltesz, L. (Magyar Tudomanyos Akademia, Budapest. Orvosradiologiai Kutato Csoport). Strahlentherapie; 149: No. 5, 513-519(May 1975). (In German).

After application of soft X-rays at 100, 500 and 1,000 R, the activity change of the acid and alcaline phosphatase in the skin of mice was studied. Observations were made immediately after the irradiation and at the 1st, 2nd, 4th, 8th, and 16th day. The measurement of the enzyme activity washable out of the skin and remaining in the skin after the washing and the total activity of the skin were determined. With the acid phosphatase it was found that the quantity washable out of the skin is unusually low; the activity values of the wash solution increase at the 2nd day after the irradiation in dependence on the applicated dose; immediately after an irradiation with 1,000 R, a significative activity increase in the wash solution appears; the homogenate activity at the 2nd day only gets a significative activity increase after the irradiation with 500 R. The alcaline phosphatase was measurable in the wash solution at no moment of the measurement. However, the alcaline phosphatase has been decreased in the homogenate with few exceptions. (GE)

**28288** X-RAY INDUCED CATARACT IN RABBIT LENS. Liem-The, K. N.; Stoles, A. L. H.; Jap, P. H. K.; Hoenders, H. J. (Katholieke Universiteit, Nijmegen, Netherlands). Exp. Eye Res.; 20: No. 4, 317-328(Apr 1975).

Experimental cataracts were obtained by x irradiation of one eye of 2-month-old rabbits with 1800 rad. In the cataractous lens, high molecular weight (HM-)crystallin is already found in great amounts in the lens cortex, whereas in the unirradiated lens this is true only for the nucleus. Electron microscopic studies of HM-crystallin from the cataractous lens cortex and nucleus revealed a wide size distribution of irregularly shaped giant aggregates. The same feature was observed for HM-crystallin of the normal nucleus, whereas only relatively small aggregates were seen in HM-crystallin of the normal cortex. The ultrastructure of the normal lens fibres exhibits an electron-dense appearance without any significant demonstrable organelles. On the other hand, the cataractous lens showed pathological changes, as demonstrated by a distinct granular content of the fibres. Indications for an interpretation of x-ray induced cataract in terms of an accelerated aging process are discussed. (auth)

**28289** EFFECT OF DIAGNOSTIC-QUALITY X IRRADIATION ON THE DEVELOPING POSTNATAL RAT RETINA. Mock, B. H.; Weidman, T. A.; Carlton, W. W.; Landolt, R. R.; Shaw, S. M. (Franklin McLean Memorial Research Inst., Chicago). Exp. Eye Res.; 20: No. 4, 293-305(Apr 1975).

The morphological effect of diagnostic-quality x rays (140 kVp, 2.35 mm Al HVL) on the developing postnatal rat retina was studied by the use of light and electron microscopy. Different litters of postnatal rats were exposed to 100 R of x rays on each of the first seven days of life. Examination with light and electron microscopy on day 8 and day 14 revealed that the postnatal retina was insensitive to the induction of permanent retinal injury at the 100 R exposure level. No visible abnormalities that could be attributed to the effect of the irradiation were demonstrated in any of the retinal layers. Animals exposed on postnatal day 3 or day 4 to 200, 300, or 500 R of diagnostic-quality x rays demonstrated severe injury within the outer layers of the sensory retina. The types of developmental lesions observed are described. It was concluded that a threshold exposure exists for diagnostic-quality x-rays which is between 100 and 200 R, and that the rat retina is considerably more radiosensitive on postnatal day 3 than on postnatal day 4. (auth)

**28290** ACTION OF TETRODOTOXIN ON THE CONTRACTILE RESPONSES OF ISOLATED GUINEA-PIG URINARY BLADDER PREPARATION TO X-IRRADIATION AND TO ELECTRICAL STIMULATION. Michailov, M. C.; Welscher, U. E.; Wolffhardt, C. M. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (F.R. Germany). Abt. Strahlenbiologie und Biophysik). Radiat. Environ. Biophys.; 11: No. 4, 289-294(Mar 1975).

Tetrodotoxin ($10^{-8}$ to $10^{-6}$ g/ml) blocked the contractile responses of isolated guinea-pig urinary bladder preparation to electrical (25 and 100 Hz) neural but not to transmural stimulation and to X-irradiation (50 kV, 20 kR/min, 20 kR). The irradiation had no influence on the bladder responses to electrical and hormonal (acetylcholine and histamine) stimulation. It is concluded that the X-ray-induced contraction is of myogenic origin and that it is possibly not related to the electro-mechanical coupling system. (GE)

**28291** RADIATION EFFECTS ON RAT TESTES. VIII. Kinetic Properties of Hydrolases Following Partial Body Gamma Irradiation of Rats. Gupta, G. S.; Bawa, S. R. (Punjab Univ.,

Chandigarh (India). Dept. of Biophysics). Strahlentherapie; 149: No. 5, 528-534(May 1975).

Kinetic properties such as Michaelis constant ($K_m$), maximum velocity, ($V_{max}$), temperature coefficient $Q_{10}$, and energy of activation, ($E_a$) for hydrolysis of adenosine-5'-phosphate at pH 9.5 and sodium pyrophosphate at pH 8.35 by normal and radiated testes supernatants are described. Kinetic parameters are related to respective phosphohydrolases (phosphatases). $K_m$ values for 5'nucleotidase and inorganic pyrophosphatase of normal testis were determined as $1.25 \times 10^{-3}$ M and $0.81 \times 10^{-3}$ M respectively; $V_{max}$ corresponds to 318 μg P/15 min and 430 μg P/15 min for 100 mg tissue respectively; $Q_{10}$ for 5'nucleotidase is 1.7 and for inorganic pyrophosphatase is 4.2 at a temperature 10-30°C; $E_a$ for hydrolysis of AMP and sodium pyrophosphate was calculated by Arrhenius plots as 17,000 and 9,000 cal/mol. $K_m$ values for irradiated enzymes are similar to the control values suggesting that the binding capacities of these enzymes with their substrates remain unaffected after radiation; $V_{max}$ for radiated enzymes correspond to a value of 500 μg P/100 mg tissue/15 min for 5'nucleotidase is 2.2 and inorganic pyrophosphatase 1.16 at 10-30°C; $E_a$ for irradiated 5'nucleotidase is comparable to those of normal rats whereas for inorganic pyrophosphatase $E_a$ is moderately declined. The observed changes are related to the different types of metabolic activity in germinal and nongerminal cells of testes. (GE)

**28292** RECONSTITUTION OF THE THYMUS DEPENDENT AREA IN THE SPLEEN OF LETHALLY IRRADIATED MICE. A Light and Electron Microscopical Study of the T-Cell Microenvironment. van Ewijk, W.; Verzijden, J. H. M.; van der Kwast, T. H.; Luijcx-Meijer, W. M. (Erasmus Univ., Rotterdam). Cell Tissue Res.; 149: No. 1, 43-60(1974).

To study the submicroscopical morphology of the microenvironment for T-lymphocytes in the spleen, mice were lethally x-irradiated and injected intravenously with syngeneic thymocytes. Twenty-four hours after cell transfer, small lymphocytes occurred in the thymus dependent area of the spleen: the periarteriolar lymphatic sheath (PALS). They localized preferentially around a special type of mononuclear phagocyte, the Interdigitating Cell (IDC), which is considered to be characteristic for thymus-dependent areas in peripheral lymphoid organs. A close cell contact between both cell types was observed: small lymphocytes protruded into the cytoplasm of the IDC by means of fingerlike protrusions. This type of cell contact seems to induce blast transformation of the lymphoid cells which resulted in the formation of medium sized T-cells. In a control experiment, spleen cells from thymectomized, x-irradiated and bone marrow reconstituted mice were injected intravenously into lethally x-irradiated recipients. These B-lymphocytes, however, were not found to be localized around IDC. They preferentially formed primary follicles at the periphery of lymphocyte-depleted thymus dependent areas. (auth)

**28293** MORPHOLOGICAL CHANGES IN SKELETAL MUSCLE AFTER TRANSPLANTATION. A Light- and Electron-Microscopic Study of the Initial Phases of Degeneration and Regeneration. Mastaglia, F. L.; Dawkins, R. L.; Papadimitriou, J. M. (Western Australia Univ., Nedlands). J. Neurol. Sci.; 25: No. 2, 227-247 (Jun 1975).

The morphological changes in subcutaneously implanted muscle homografts in mice were studied by light and electron microscopy 1 to 23 days after transplantation. The initial degenerative changes were identical in isografts and allografts and were essentially the same as those found in muscle explants in tissue culture and after various forms of muscle injury. Regenerative changes were prominent at the periphery of grafts by 48 to 72 hr before evidence of graft revascularization could be demonstrated by India ink perfusion. Active regeneration occurred in isografts and in allografts during the first week resulting in the formation of a new population of muscle fibres. Rejection subsequently occurred in allografts between days 7 to 14. Regeneration was retarded or completely inhibited by exposure of the donor animal to 1,500 rad of x irradiation 1 to 2 hr prior to transplantation suggesting that regeneration is brought about by cells derived from the graft. Electron-microscopic observations in 48 to 72 hr grafts suggested that primitive mononucleated myogenic cells may form within degenerating muscle fibers by a process of myonuclear sequestration. Inactive satellite cells were present in the muscle from which grafts were taken in some donor animals but no definite conclusions could be reached as to the role of these cells in graft regeneration. (NL)

**28294** EFFECT OF SOME CYTOSTATICS ON TYROSINE AMINOTRANSFERASE ACTIVITY IN RAT LIVER. Popov, P. G.; Kavrakirova, S. V.; Belokonskii, I. S.; Golovinskii, E. V. (Higher Military Medical Inst., Sofia). Acta Biol. Med. Ger.; 29: No. 6, 751-755(1972).

The cytostatics cyclophosphamide, 6-mercaptopurine, and amethopterine give a late maximum of tyrosine aminotransferase (TAT) activity (at the 72nd hour after their application), which is analogous to that observed after x irradiation and is probably due to common pathogenetic mechanism. Cyclophosphamide and 6-mercaptopurine bring about also an early maximum (at the 4th hour), followed by a full return to normal values, so that TAT shows a biphasic curve analogous to that after x irradiation. The second maximum (at the 72nd hour) after application of the aforementioned cytostatics is also observed in adrenalectomized animals. (auth)

**28295** RESPONSE OF SPERMATOGONIA OF THE MOUSE TO HYCANTHONE: A COMPARISON WITH THE EFFECT OF GAMMA RAYS. Oakberg, E. F. (Oak Ridge National Lab., TN). pp 197-207 of Physiology and Genetics of Reproduction. Part A. Coutinho, E. M.; Fuchs, F. (eds.). New York; Plenum Press (1974).

From 13th international symposium on physiologic and genetic aspects of reproduction; Salvador, Brazil (2 Dec 1973). See CONF-731222--PA.

The response of mouse spermatogonia cells to the toxic effects of hycanthone were compared with the effects of x and gamma radiations, using cell survival as the criteria. (CH)

**28296** STUDIES CONCERNING THE EFFECT OF X-RAYS ON ELECTROLYTIC SHIFTS AND ON THE METABOLISM OF THE MYOCARDIUM. V. Radiation-Induced Changes in Enzyme Activities and Metabolites of the Glycolysis. Prignitz, R.; Hoffmeister, N.; Hoffmeister, G. (Marburg Univ. (F. R. Germany). Klinik und Poliklinik fuer Strahlentherapie und Roentgendiagnostik). Strahlentherapie; 149: No. 6, 621-627(Jun 1975). (In German).

The behavior of enzyme activities, substrates and metabolites of glycolysis as well as of the pentose phosphate shunt following local irradiation (250 to 6000 R surface dose) is biochemically investigated in the guinea pig's myocardium. During irradiation, an activation of phosphorylase-a occurs while the total phosphorylase content remains unchanged. Enzyme activities of hexokinase and phosphofructokinase increase with dosage and time. The glycogen content decreases; tissular concentration of the metabolites glucose-1-phosphate, glucose-6-phosphate, glyceraldehyde-3-phosphate, glycerol-3-phosphate, and pyruvate increases following irradiation; the content of fructose-1,6-diphosphate, dihydroxyacetone-phosphate, and lactate is decreased. The activity of glucose-6-phosphate-dehydrogenase is slightly inhibited, whereas 6-phosphogluconate-dehydrogenase remains unaffected. (GE)

**28297** STUDIES ON COMBINED INJURIES. XXII. Investigations on Serum Proteins of Mice After Whole-Body Irradiation Combined with Open Skin Wounds. Henneberg, R.; Messerschmidt, O.; Maurer, G. (Laboratorium fuer Experimentelle Radiologie, Neuherberg/Muenchen (F. R. Germany); Technische Univ. Muenchen (F. R. Germany). Chirurgische Klinik und Poliklinik). Strahlentherapie; 149: No. 6, 636-649(Jun 1975). (In German).

After combined injuries, much more pronounced changes in the protein composition of serum develop than simply after skin wounding or irradiation. A decrease was found in the prealbumin, albumin, $\alpha_1$-globulin and $\gamma$-globulin fractions while the $\alpha_2$-globulin and $\beta$-globulin fractions increased. If skin wounds were inflicted prior to or almost simultaneously with irradiation, the radiation-induced serum protein changes become normalized earlier. If skin wounds were inflicted after irradiation, very pronounced alteration in the protein picture occurs. If the skin wounds are inflicted 21 days after irradiation, they appear to have nearly no influence on augmentation of protein changes. The $\gamma$-globulin content increases considerably after the 14th day after irradiation. An additional skin wound, however, causes a depression of the $\gamma$-globulins; but the values are still significantly higher than normal. (GE)

**28298** VERIFICATION OF THE GASTROINTESTINAL HEMORRHAGES IN THE ACUTE RADIATION SYNDROME. Brueckner, V. (Hamburg Univ. (F. R. Germany). Inst. fuer Biophysik und Strahlentherapie; 149: No. 6, 597-601(Jun 1975). (In German).

Increased radioiron excretion with feces following irradiation is a sure indicator of thrombopenia-induced gastrointestinal hemorrhages which are to be regarded as one of the main causes of the acute radiation syndrome or radiation death respectively. The daily $^{59}$Fe-excretion was analyzed for whole-body irradiated mice from the 7th to the 16th day after irradiation, this period being the critical phase in the course of acute radiopathy with a mortality amounting to about 50% of the irradiated animals (bone-marrow syndrome). On the eleventh day after radiation exposure, $^{59}$Fe-excretion of irradiated animals significantly exceeded by more than fivefold that of the controls. If, before radiation exposure, the mice had been treated with the protective agent, AET, they survived without exception and, moreover, a significantly reduced

$^{59}$Fe-excretion was noted too, the control values almost being reached again. By means of the radionuclide $^{59}$Fe therefore, the functional state of the erythropoietic system can be discerned and troubles of the hemostatic system can be detected, e.g., the pathological transition of blood into the gastrointestinal tract. (GE)

**28299** EFFECTS OF CONTINUOUS IRRADIATION ON ANIMAL POPULATION. Turner, F. B. (Univ. of California, Los Angeles). Adv. Radiat. Biol.; 5: 83-144(1975).

Data are reviewed from studies on the effects of continual gamma irradiation on terrestrial and freshwater animal populations. Emphasis is placed on processes of reproduction and survival, and hence on the size and age composition of animal populations. (250 references). (CH)

**28300** RADIATION-INDUCED LIFE-SHORTENING AND PREMATURE AGING. Walburg, H. E. Jr. (Oak Ridge National Lab., TN). Adv. Radiat. Biol.; 5: 145-179(1975).

Data from a number of studies on irradiated laboratory animals showed that almost none of the characteristic lesions associated with senescence that were studied adequately reflects a radiation effect analogous to premature aging. In fact, most of the age-related changes showed no effect of radiation at all, and many of those that did (for example, graying of hair, sterility, cataract formation) did not appear to be due to similar mechanisms. It is concluded that, in the light of more recent information, the hypothesis of radiation-induced premature aging requires reassessment. (80 references) (CH)

**28301** MENHADEN AND POWER PLANTS: A GROWING CONCERN. Young, J. S. (Middle Atlantic Coastal Fisheries Center, Highlands, NJ). Mar. Fish. Rev.; 36: No. 10, 19-23 (Oct 1974).

The economic importance and biology of menhaden are discussed. The hazards of power plants along inshore waters to marine fishes, particularly the estuarine menhaden, are reviewed. The chief hazards associated with power plants are heat shock, cold shock, impingement on intake screens, gas embolisms, biocides, and entrainment. (HLW)

**28302** MUTAGENIC EVALUATION OF AN ALCOHOLIC EXTRACT FROM γ-IRRADIATED POTATOES. Levinsky, H. V.; Wilson, M. A. (Bio Research Labs., Ltd., Pointe Claire, Quebec). Food Cosmet. Toxicol.; 13: No. 2, 243-246(Apr 1975).

A mutagenic study was carried out on extracts of irradiated and non-irradiated potatoes using the dominant lethal test in the mouse. Potatoes were irradiated with approximately 12 krad of γ radiation and an alcoholic extract prepared from them was given to a group of five male mice by gavage for 7 days. For comparison, two additional groups, each of five male mice, were given an extract of non-irradiated potatoes and physiological saline, respectively. Each male was then mated sequentially with three female mice for each of five successive weeks. The females were killed on day 18 after their caging with a male. Corpora lutea were counted and examinations were made for live, dead, and resorbed embryos. The feeding of extracts of irradiated or non-irradiated potatoes had no effect on pregnancy rates, total numbers of implantation sites, or early and late foetal deaths. No mutagenic effect was observed following these treatments. (auth)

**28303** INFLUENCE OF X-RAY AND ULTRAVIOLET RADIATION ON THE DIURNAL RHYTHM OF ACID PHOSPHATASE ACTIVITY AND INORGANIC PHOSPHATE LEVEL IN THE THYMUS OF SEXUALLY IMMATURE AND MATURE MICE. Barbacka, G. (Univ. Jagiellonski, Krakow). J. Interdiscip. Cycle Res.; 5: No. 2, 95-114(Sep 1974). (ISSN 00221945).

## *Invertebrates*

*Refer also to abstracts 28147–28150 and 28299.*

**28304** (UCSD-34P150X4) GENETIC CONTROL OF GAMETOGENESIS IN DROSOPHILA MELANOGASTER. Cook, D. J. (California Univ., San Diego (USA)). 1975. Contract AT(04-3)-34. 25p. Dep. NTIS $4.25.

Genetic control of meiosis is discussed with regard to selection of mutants; screening of EMS-treated chromosomes; effects of meiotic mutants on mitotic exchange; and effects of x radiation on meiotic mutants. Studies on spermatogenesis are discussed with regard to genetic control, regulation of gene activity, and polarity switches in chromosomal DNA. A proposed study of the sterility of sons of irradiated fathers is described. (HLW)

**28305** CHARACTERISTICS OF REPLICATION AND RADIATION RESPONSE OF AEDES ALBOPICTUS CELL LINE IN VITRO. Lee, C. K. Urbana, IL; University of Illinois (1974). 88p. University Microfilms Order No. 75-11,806.

Thesis (Ph. D.).

The radiosensitivity of the line of Aedes albopictus cells was investigated by scoring x-ray-induced chromosome aberrations as a function of dose and of time after irradiation as well as the modification by dose fractionation. In order to obtain these data, a series of studies, e.g., karyotype, cell life cycle, radiation-induced mitotic delay, and frequency and type of spontaneous aberrations, were carried out. Cells from this line had three pairs of chromosomes as a stem line chromosome number. The morphology of the chromosomes is metacentric. Somatic pairing between homologous chromosomes was observed as a common event and there was a high frequency of achromatic gaps on the chromosomes. These observations are in good agreement with those made in other laboratories. The generation time of A. albopictus cell line was approximately 32 hours, in which $G_1$, S, and $G_2$ phases were 2½, 24 and 5½ hours respectively. This generation time is in agreement with the population doubling time observed in our cell growth studies. By contrast, in most mammalian cells, $G_1$ usually is the longest phase and S is comparatively short. Dose fractionation studies indicated that A. albopictus cells in culture may have a faster chromosome repair system than mammalian and other cell systems. This may, at least in part, explain the difference in radiosensitivity between A. albopictus cell line and other cell systems. (Diss. Abstr.)

**28306** RELATIONSHIP BETWEEN THE FREQUENCY OF TWO TYPES OF LETHAL-MUTATION AND X-RAY DOSES IN DROSOPHILA. Matsudaira, Y.; Yamasaki, T. (Rikkyo Univ., Tokyo). Mutat. Res.; 27: No. 3, 341-346(Mar 1975).

The dose-frequency relationship for each of two types of lethal mutations, fractional- and whole-lethal, was obtained using x rays on Drosophila melanogaster. The results show that the fractional-lethal mutations are induced by x rays, and also that the proportion of fractional-lethal mutations in the total of mutations tends to decrease with increasing doses, namely, 61% at 0 R, 47% at 500 R, 37% at 1000 R, and 20% at 2000 R. The same tendency is observed with visible mutations. In order to consider the problems related to the above results, the relationship between the true frequency and the observed frequency of the induced lethal mutations is discussed, taking into consideration the existence of the ostensible whole-lethal and the ostensible normal. (NL)

**28307** RADIORESISTANCE IN NATURAL POPULATIONS OF DROSPHILA NEBULOSA FROM A BRAZILIAN AREA OF HIGH BACKGROUND RADIATION. Kratz, F. L. (Goias Federal Univ., Goiania-Go, Brazil). Mutat. Res.; 27: No. 3, 347-355(Mar 1975).

Drosophila nebulosa, collected in two woods of a high background radiation area in Brazil, were compared and found to be more resistant than flies collected as controls in two other woods of an adjacent area. This was the second time that average differences in radioresistance between natural populations were established. Previous experiments were carried out with D. willistoni in the same area and in comparable fashion. In spite of their higher radiation resistance, the flies from the radiation area carried a higher expressed load than the controls. The following tests were performed to estimate the differences: a) survival, after whole-body exposure to 90,000 R of $^{60}$Co gamma rays on 120 strains set up from single inseminated females, and b) reproductive performance in 240 duplicate crosses measured in terms of the difference between irradiated series (males received 3000 R of $^{60}$Co gamma rays) and their unirradiated counterparts. The data are based on an offspring of 293,784 individuals. Furthermore, two diallel crosses between sensitive and resistant strains have shown that the differences probably are due mainly to additive genes. (NL)

**28308** X-RAY- AND TEM-INDUCED MITOTIC RECOMBINATION IN DROSOPHILA MELANOGASTER: UNEQUAL AND SISTER-STRAND RECOMBINATION. Becker, H. J. (Muenchen Univ. (F. R. Germany). Zoologisches Inst.). Mol. Gen. Genet.; 138: No. 1, 11-24(Jun 1975).

4 tabs.; 4 figs.; 23 refs.

Twin mosaic spots of dark-apricot and light-apricot ommatidia were found in the eyes of $w^3/w^a$ females, of $w^a$ males, of females homozygous for In(1)sc$^4$, $w^a$ and of attached-X females homozygous for $w^a$. The flies were raised from larvae which had been treated with 1,630 R of X-rays at the age of 48-52 hours. An additional group of $w^3/w^a$ females and $w^a$ males came from larvae that had been fed with triethylene melamine (TEM) at the age of 22-24 hours. The twin spots apparently were the result of induced unequal mitotic recombination, i.e., from unequal sister-strand recombination in the males and from unequal sister-strand recombination as well as, possibly, unequal recombination between homologous strands in the females. That is, duplication resulted in $w^aDpw^3/w^a$ dark-apricot ommatidia and the corresponding deficiency in an adjacent area of $w^a/Dfw^a$ light-apricot ommatidia. In an additional experiment sister-strand mitotic recombination in the ring-X chromosome of ring-X/rod-X females

heterozygous for w and $w^{co}$ is believed to be the cause for X-ray induced single mosaic spots that show the phenotype of the rod-X marker. (GE)

# Radionuclide Effects (Internal Source)

## Man

*Refer also to abstracts 27950, 28248, 28275, 28309, 28328, 28733, and 30374.*

**28309** (FMI-42, pp 33-41) MEDICAL PHYSICS, RADIOBIOLOGY, AND THERAPY. 1975.

In annual report, 1975. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)).

The regulation of hemopoietic stem cell proliferation was explored by administration of strontium-89 to mice, which causes damage of bone marrow cells and a shift of blood formation to the spleen. Three dosimetric techniques are described that are in use with californium-252 interstitial sources to provide accurate gamma and neutron dose measurements close to these sources with special attention paid to the effect of moderation of neutrons by tissue components which contain hydrogen. A computerized program for calculation of three-dimensional dose distributions from $^{252}Cf$ point sources has been developed. The use of iodine-125 as a photon source for diagnostic bone mineral measurements by transmission scanning was extended to a variety of diseases. A dose-response evaluation of the health risk from potential energy-related carcinogens makes use of in vivo bioassays developed previously. Methods are available for assessment of a variety of energy-related chemical and ionizing pollutants in regard to their late effects on biological systems. In a correlated laboratory and clinical investigation of patients with Hodgkin's disease and non-Hodgkin's lymphoma, precise clinical and pathological staging, rigorously controlled chemotherapy and radiation therapy protocols, and study of abnormal cells by biochemical, immunological, and ultrastructural methods were designed for better definition, early diagnosis, and curative therapy of these malignant disorders. (CH)

**28310** RESULTS OF THE TREATMENT OF GRAVE'S DISEASE BY $^{131}I$. Riviere, J.; Roger, P.; Nogue, F.; Emperaire, J. C.; Latapie, J. L.; Reboul, J.; Blanquet, P. (Hopital Saint-Andre, Bordeaux). Ann. Endocrinol. (Paris); 35: 38-39(1974). (In French).

The study of 179 cases of hyperthyroidism treated by $^{131}I$ at small and repeated doses, with clinical and biological control, between 5 and 12 years after iodine was last administered, gave the following results: Euthyroidism (clinical and biological), 142 (72.82%); Hypothyroidism (clinical and biological), 22 (11.28%); and Hyperthyroidism (clinical and biological), 3 (1.58%). Clinical euthyroidism: Biological hypothyroidism, 8 (4.1%); Biological hyperthyroidism, 2 (1.02%); and Without biology, 1 (0.51%). Clinical hypothyroidism: Normal biology, 1 (0.51%). (auth)

**28311** INCIDENCE OF HYPOTHYROIDISM AFTER TREATMENT OF THYROTOXIC DISEASE BY $^{131}I$ AND SURGERY. Ermans, A. M.; Bastenie, P. A. (Experimental Medicine Lab., Brussels). Ann. Endocrinol. (Paris); 35: 69-71(1974). (In French).

The incidence myxedema after treatment of hyperthyroidism by $^{131}I$ or surgery considerably varies with the authors, techniques used, and the means of diagnosis of the hypothyroidism. At short-term the growth of myxedema is much more rapid after surgery than after $^{131}I$. At long-term the incidences are nearly superimposable (20 to 25%). (auth)

**28312** DEMONSTRATION OF RADIOACTIVE GOLD AND MERCURY IN SYNOVIAL TISSUE INTRA-ARTICULAR FOLLOWING INJECTION OF RADIOACTIVE GOLD. Mohr, W.; Hersener, J.; Richter, R.; Beneke, G.; Sievers, B. U. (Univ. Ulm, Ger.). Z. Rheumatol.; 33: No. 7-8, 284-290(1974). (In German).

Synovial tissue and synovial fluid cells were investigated after intraarticular administration of radioactive gold ($^{198}Au$). By autoradiographic investigations $^{198}Au$ was detected in synovial fluid cells, synovial lining cells, and macrophages in the synovial membrane. Examinations by means of energy-dispersive x-ray microanalysis demonstrated gold and mercury depositions in the synovial membrane. The existence of mercury 8 weeks after administration of radiogold may be responsible for the long-standing therapeutic effect of radiogold therapy. (auth)

## Animals

**28313** CYTOGENETIC EFFECTS OF PLUTONIUM-239 IN MALE MICE. Beechey, C. V.; Green, D.; Humphreys, E. R.; Searle, A. G. (Medical Research Council, Harwell, Eng.). Nature (London); 256: No. 5518, 577-578(14 Aug 1975).

A study is described on the induction of chromosome aberrations in the germ cells of male mice after protracted exposure to $\alpha$ radiation from $^{239}Pu$. Some young male mice were injected intravenously with 10 $\mu$Ci/kg. $^{239}Pu$ in trisodium citrate solution and compared with controls. After a few weeks the mice were killed and chromosome preparations were made from cellular suspensions of each right testis, while the left was used for radiochemical assay of Pu. Spermatocytes were scored for chromosome anomalies. Sperm counts were also made from the epididymis, in addition to examinations for head abnormalities. Testis weight declined to 58% of that of controls after 18 weeks and the mean epididymal sperm count was only 51% of the controls, showing that much of the weight loss was the result of germ cell death. The mean frequency of sperm head abnormalities was 9% compared with 4.6% in controls. The overall fragment frequency was about 3.4% compared with a control frequency of about 1.3%. An increase in the frequency of spermatocytes with quadrivalent configurations was observed, and this is discussed. Comparisons are made with effects caused by x- and $\gamma$-rays and neutrons. (UK)

# Nuclide Kinetics and Toxicology

## Man

*Refer also to abstract 30315.*

**28314** MEASUREMENT OF BONE MINERAL AND BODY COMPOSITION BY THE ATTENUATION OF THREE LOW-ENERGY RADIATIONS FROM $^{241}Am$. Kairento, A. L.; Spring, E. (Helsinki Univ. Central Hospital). Ann. Clin. Res.; 6: No. 2, 80-85 (1974).

A study was made of a technique for the determination of three components of the body-bone minerals, soft tissue, and fat, from their attenuation of low-energy gamma radiation. The attenuations at radiation energies of 20.8, 26.4 and 59.6 keV of $^{241}Am$ were derived by means of a Ge(Li)-detector. The method was tested with samples of known composition, and the following mean deviations between the measured and the true values were obtained: 1% for bone minerals, 12% for soft tissue, and 5% for fat. The main advantage of the method is that it takes fat into account, as failure to do so previously introduced a systematic error into the measurements. (auth)

**28315** STRONTIUM ABSORPTION THROUGH DAMAGED AND UNDAMAGED HUMAN SKIN. Ilyin, L. A.; Ivannikov, A. T.; Parfenov, Y. D.; Stolyarov, V. P. (Inst. of Biophysics, Moscow). Health Phys.; 29: No. 1, 75-80(Jul 1975).

The absorption of $^{85}Sr$ was investigated in an experiment on 12 volunteers, with undamaged and traumatized human skin (scratches). The skin scratches were applied with a metal grater in the region of the forearm. The absorption of $^{85}Sr$ through skin was measured on the basis of external $\gamma$-radiation measurements from the whole body, bone tissue (patella), and from data on the daily excretion of $^{85}Sr$, which were compared with data obtained after intravenous injection of the radionuclide. Six hours after contact, 0.26% of $^{85}Sr$ applied is absorbed through undamaged skin. Over the same period 57.4% of $^{85}Sr$ applied is absorbed through damaged skin or more than 200 times as much as undamaged skin. Most of $^{85}Sr$ is absorbed during the first 30 min after application, amounting to 38.0% of the total quantity applied. (auth)

**28316** ON THE "DISSOLUTION" OF RESPIRABLE $PuO_2$ PARTICLES. Fleischer, R. L. (General Electric Co., Schenectady, NY). Health Phys.; 29: No. 1, 69-73(Jul 1975).

Previous measurements of an apparent solubility of $PuO_2$ particles in simulated lung fluid are inconsistent with there being significant chemical solubility. The results do agree with a model in which small scale, progressive fragmentation of the particles is caused by radiation damage by the recoil nuclei from $\alpha$ decay. (auth)

**28317** CLEARANCE RATES OF INSOLUBLE PLUTONIUM-239 COMPOUNDS FROM THE LUNG. Watts, L. (National Radiological Protection Board, Harwell, Eng.). Health Phys.; 29: No. 1, 53-59(Jul 1975).

There are indications that the process of clearance of inhaled insoluble plutonium compounds from the lung may be represented by a model consisting of three exponential phases. A survey of published data on in vivo and bioassay measurements made after $^{239}PuO_2$ inhalation by men and large animals has been carried out, and the half-times of the three exponential phases determined as approx 1 day, 30 days, and 500 days. (auth)

## Animals

*Refer also to abstracts 27925, 27928, 27931, and 27957.*

**28318** (INIS-mf-1623) AN ATTEMPT TO ACCELERATE STRONTIUM-85 EXCRETION BY COMBINED ADMINISTRATION OF DECORPORATING AGENTS. Nikolov, I.; Bokova, N.; Kiradzhiev, G.; Mikhajlov, M. A. (Ministerstvo na Narodnoto Zdrave, Sofia (Bulgaria); Meditsinska Akademiya, Sofia (Bulgaria); Nauchno Druzhestvo na Rentgenolozite i Radiolozite, Sofia (Bulgaria). Sektsiya po Radiologiya). 1973. 6p. (In Bulgarian). INIS.

From 3rd national conference on radiology and radiobiology; Plovdiv, Bulgaria (1 Nov 1973).

Possibilities of speeding up radiostrontium excretion by combined administration of decorporating preparations differing in mechanism of action were investigated. The substances used acted either by inhibiting calcification or stimulating decalcification, by isotope dilution, or by limiting adsorption from the GI tract. The results obtained indicate that combined administration does not result in additivity of effects. Combinations containing stable strontium as one of the constituents not only failed to show decorporating properties but even produced conditions favorable to an increased deposition of the isotope in the body. (auth)

**28319** (INIS-mf-1624) A STUDY ON THE POSSIBILITIES OF SODIUM HEXAMETAPHOSPHATE IN DECORPORATING RADIOSTRONTIUM. Bokova, N.; Nokolov, I.; Mikhajlov, M. A.; Kiradzhiev, G. (Ministerstvo na Narodnoto Zdrave, Sofia (Bulgaria); Meditsinska Akademiya, Sofia (Bulgaria); Nauchno Druzhestvo na Rentgenolozite i Radiolozite, Sofia (Bulgaria). Sektsiya po Radiologiya). 1973. 7p. (In Bulgarian). INIS.

From 3rd national conference on radiology and radiobiology; Plovdiv, Bulgaria (1 Nov 1973).

The effect of sodium hexametaphosphate on radiostrontium excretion was studied with regard to dosage as well as routes and times of administration. Maximum percent decorporation (more than 60%) was obtained when oral hexametaphosphate was given at 1 g/kg b.w. 10 minutes and 24 hours after radiostrontium intake. Combinations with other decorporating agents acting by different mechanisms failed to enhance the decorporative effect of sodium hexametaphosphate. (auth)

**28320** EXCRETION OF DIFFERENT FORMS OF ZINC BY THE PRAWN PALAEMON SERRATUS (PENNANT). Small, L. F. (Oregon State Univ., Corvallis); Keckes, S.; Fowler, S. W. Limnol. Oceanogr.; 19: No. 5, 789-793(Sep 1974).

Freshly collected specimens of Palaemon serratus from the upper Adriatic Sea were used to determine excretion rates of zinc in zinc-free water by anodic stripping polarographic techniques. Weight-specific excretion of total zinc varied reciprocally with body weight, apparently in a log–log relationship. Weight-specific excretion of ionic-particulate zinc appeared greatest in short term (1 to 3 hr) experiments, while weight-specific excretion of complexed zinc appeared greatest in longer term (4 to 5 hr) experiments; however, we cannot exclude the possibility that ionic-particulate zinc and dissolved organic compounds were excreted separately and subsequently combined in the water to yield zinc complex. (auth)

**28321** EFFECT OF COMBINATIONS OF CHELATING AGENTS ON THE TRANSLOCATION OF INTRAMUSCULARLY DEPOSITED $^{239}$Pu NITRATE IN THE RAT. Volf, V. (Kernforschungszentrum, Karlsruhe, Ger.). Health Phys.; 29: No. 1, 61-68(Jul 1975).

The effect of direct injection of chelating agents into simulated puncture wounds contaminated with $^{239}$Pu nitrate has been investigated. The ability to stimulate absorption of $^{239}$Pu from the injection site decreases in the order: Desferrioxamine (DFOA) > calcium diethylenetriaminepentaacetate (DTPA) > disodium dipicolinate > trisodium citrate. Substantially better results are obtained by simultaneous administration of mixtures of DTPA + dipicolinate, DTPA + DFOA, DFOA + citrate, and DTPA + citrate, all showing virtually the same effectiveness. The retention pattern of $^{239}$Pu translocated from the wound into body organs after chelation therapy is considered as a measure of the complex stability in vivo. Greatest reduction in the skeleton and liver is achieved by DTPA and by its combination with DFOA or citrate. On the other hand, the $^{239}$Pu transferred from the injection site shows increased proportional deposition in the kidneys by DFOA, in the skeleton by kipicolinate and in the liver and skeleton by citrate. Combinations of DTPA with tartrate, lactate, pyruvate, or chinolinate as well as those of citrate with dipicolinate or chinolinate are equally or less effective than DTPA or DFOA alone. Hyaluronidase does not influence the effectiveness of treatment. Up to about 90% of $^{239}$Pu can be removed from the injection site by treatment 1 hr after administration and up to about 30% 3 weeks later. Practical implications of these findings are discussed. (auth)

**28322** DEPENDENCE OF DTPA-TOXICITY ON THE TREATMENT SCHEDULE. Planas-Bohne, F.; Ebel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Health Phys.; 29: No. 1, 103-106 (Jul 1975).

The toxicity and cumulative $LD_{50}$ of Ca-DTPA in rats show a pronounced dependence on the treatment schedule. If with repeated injections the daily dose is given in several fractions rather than as a single daily injection, the $LD_{50}$ decreases by approx 50%. The highly fractionated regimen brings also about a more pronounced impairment of erythropoiesis and increased urinary excretion of zinc. No toxic effects were observed for Zn-DTPA. The practical implications of these findings are discussed. (auth)

**28323** EFFECT OF TIME POST-EXPOSURE ON THE EFFECTIVENESS OF BRONCHOPULMONARY LAVAGE IN REMOVING INHALED $^{144}$Ce IN FUSED CLAY FROM BEAGLE DOGS. Felicetti, S. A.; Silbaugh, S. A.; Muggenburg, B. A.; Hahn, F. F. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). Health Phys.; 29: No. 1, 89-96(Jul 1975).

The effectiveness of a single, unilateral bronchopulmonary lavage in removing relatively insoluble radioactive material from the lung was evaluated at various times after inhalation exposure to radioactive aerosol in dogs. Twenty-seven beagle dogs exposed to aerosols of $^{144}$Ce fused clay achieved initial lung burdens ranging from 23 to 73 mu Ci/kg body weight. The dogs were divided into nine groups of three dogs each and each group was given a single bronchopulmonary lavage of the right lung at one of the following times after exposure; 2 hr, 2, 4, 7, 14, 28, 56, 128, and 196 days. Mean percentages of the right lung burden recovered in the lavage fluid were: 45, 25, 22, 19, 25, 12, 17, 14, and 17 percent, respectively. After the lung lavage, the dogs were sacrificed, dissected, and the tissues analyzed. At least 93 percent of the sacrifice body burden was found in the lungs out to 56 days after exposure. At 128 and 196 days after exposure, lung burdens were means of 88 and 81 percent of the sacrifice body burden, respectively. The results indicate that a sizable percentage of the insoluble particles in the lung remains accessible to removal by bronchopulmonary lavage for periods up to 6 months after exposure; however, translocation from the lungs to other tissues increases with time. Also, depending on the isotope, the total radiation dose delivered to lung before lavage can become so large at longer times after exposure that removal of material from the lung has little effect in reducing total cumulative dose to tissues. (auth)

**28324** MULTIPLE BRONCHOPULMONARY LAVAGES FOR THE REMOVAL OF $^{144}$Ce IN FUSED CLAY PARTICLES FROM BEAGLE DOG LUNGS. Silbaugh, S. A.; Felicetti, S. A.; Muggenburg, B. A.; Boecker, B. B. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). Health Phys.; 29: No. 1, 81-88(Jul 1975).

Repeated bronchopulmonary lavage was investigated as a method of removing inhaled $^{144}$Ce fused clay particles from the lungs of beagle dogs. Eight beagle dogs were exposed to a fused clay aerosol containing $^{144}$Ce resulting in initial lung burdens ranging from 47 to 71 mu Ci $^{144}$Ce/kg body weight. Three of these dogs received 20 saline lavage treatments, 10 per lung, over an 84-day period. The first 10 lavages were given within 24 days as an accelerated schedule. A fourth dog, originally scheduled for 20 lavage treatments, received only 11 before its accidental death. The other four dogs that inhaled the radioactive aerosol were not lavaged. Two additional dogs, exposed to an aerosol of fused clay containing stable cerium, also received 20 lung lavages; 10 per lung over an 84-day period. A mean of 52 percent of the initial lung burden was removed as a result of the 20 lavage treatments of three dogs exposed to the radioactive aerosol. The removal of $^{144}$Ce by lavage resulted in the reduction of the cumulative radiation dose to lung to 90 days by 46 percent and potential infinite dose by 53 percent. When the results of the accelerated schedule of 10 lavages within 24 days were compared with those from an extended schedule of 10 lavages within 56 days, the average amounts of ILB activity removed were similar, 41.4 and 44 percent, respectively. At 14 months post-exposure, the three remaining lavaged dogs are alive and under observation. Three of the four dogs that were exposed to the radioactive aerosol but not lavaged died between 7 and 8 months post-exposure. The remaining $^{144}$Ce exposed, unlavaged dog is alive at 18 months post-exposure. (auth)

**28325** IMPROVED TECHNIQUE FOR NEUTRON-INDUCED AUTORADIOGRAPHY OF BONE CONTAINING PLUTONIUM. Fellows, M. H. (Massachusetts Inst. of Tech., Cambridge); Clark, L. Jr.; O'Toole, J. J.; Kimmel, D. B.; Jee, W. S. S. Health Phys.; 29: No. 1, 97-101(Jul 1975).

A technique for neutron-induced autoradiography of bone containing small amounts of $^{239}$Pu (0.015 mu Ci $^{239}$Pu/kg body weight or less injected intravenously), which ensures both a bone image and fission fragment tracks, is described. It calls for (1) irradiation of a specimen attached to a Lexan polycarbonate detector to produce adequate numbers of $^{239}$Pu fission fragment tracks in the Lexan, (2) annealing of the detector to erase most background

damage, (3) re-irradiation of the detector with specimen still attached to regenerate a bone image, and (4) etching of the detector to accent and fix the tracks and bone image. This method has proven over 90 percent successful in generating neutron-induced autoradiographs with both a bone image and fission fragment tracks. (auth)

### Plants

**28326** STUDIES ON THE BEHAVIOR OF LEAD IN WOOD. Binding of Free and Complexed $^{210}Pb$ to Xylem Tissue. Lepp, N. W.; Dollard, G. J. (Liverpool Polytechnic (UK). Dept. of Biology). Oecologia (Berlin); 16: No. 4, 369-373(1974).

The binding of lead to xylem tissue has been studied using an isolated segment perfusion technique. The results show that free lead ions bind more readily to xylem tissue than does lead in the form of a lead-glycine complex. A small, but significant proportion of the applied lead moves laterally from wood to bark. Both binding and lateral movement of lead are shown to be time-dependant. The results are discussed in terms of using trees and the chemical analysis of their annual growth rings to date heavy metal pollution histories. (GE)

**28327** DEPOSITION, RETENTION, AND INTERNAL DISTRIBUTION OF $^{155}Eu$, $^{144}Ce$, $^{125}Sb$, $^{106}Ru$, $^{95}Zr$, $^{54}Mn$, AND $^{7}Be$ IN THE REINDEER LICHEN CLADONIA ALPESTRIS, 1961–1970. Mattsson, L. J. S. (Univ. of Lund, Sweden). Health Phys.; 29: No. 1, 27-41(Jul 1975).

The retention and distribution of the artificially produced radionuclides $^{155}Eu$, $^{144}Ce$, $^{137}Cs$, $^{125}Sb$, $^{106}Ru$, $^{95}Zr$, and $^{54}Mn$ and the naturally occurring radionuclide $^{7}Be$ have been studied in undisturbed natural carpets of the reindeer lichen Cladonia alpestris collected in the Lake Rogen district in central Sweden (62.3°N, 12.4°E) during the period 1961 to 1970. The contents of the artificially produced radionuclides in the lichen carpet reached their maxima in 1963 to 1966. The following maximum values were obtained for undisturbed lichen carpets: $^{155}Eu$ – 18 ± 2 nCi $m^{-2}$, $^{144}Ce$ – 250 ± 25 nCi $m^{-2}$, $^{125}Sb$ – 6.5 ± 0.5 nCi $m^{-2}$, $^{106}Ru$ – 50 ± 4 nCi $m^{-2}$, and $^{54}Mn$ – 15 ± 3 nCi $m^{-2}$. For all radionuclides, except $^{125}Sb$, the maximum activity concentrations were found in the top layer of the lichen carpet. According to increasing depth-penetration in the lichen carpet the radionuclides may be arranged in the following sequence: $^{144}Ce \sim {}^{7}Be \ll {}^{95}Zr < {}^{137}Cs < {}^{106}Ru \lesssim {}^{155}Eu \ll {}^{125}Sb$. During the period 1961 to 1975 the total absorbed dose in the lichen vegetation will be ~15 rad with the main contribution (~40%) coming from the radionuclides $^{144}Ce$ and $^{144}Pr$. (auth)

### Microorganisms

*Refer also to abstract 27941.*

## New Tracer Techniques

*Refer also to abstracts 27646 and 28325.*

**28328** (FMI-42) ANNUAL REPORT, 1975. Lanzl, E. F. (ed.). (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1975. Contract E(11-1)-69, 61p. Dep. NTIS $5.45.

A list is included of some 100 staff publications during the period covered. Two sections of the report have been announced in Nuclear Science Abstracts and two sections have been announced in ERDA Research Abstracts. (CH)

*For abstracts of individual sections see: 28309 and 28329.*

**28329** (FMI-42, pp 42-50) NUCLEAR MEDICINE AND IMAGING STUDIES. 1975.

In annual report, 1975. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)).

Improvements in the operation of the FMI cyclotron have made possible the production of several new short-lived radionuclides for clinical applications. Materials under study include rubidium-81 for myocardial imaging, krypton-81m for lung imaging, carbon-11-labeled urea in brain studies, and $^{11}CO$ as a blood pool imaging agent. The synthesis of L-asparagine incorporating nitrogen-13, the use of $^{129}Co$ and $^{130}Cs$ in myocardial imaging, of mixtures of $^{107}In$, $^{109}In$, and $^{109}In$ for placental imaging, and of astatine-211 for protein labeling, as well as skeletal localization studies with various isotopes have been among the recent applications of cyclotron-produced radionuclides. The use of positron emitters for imaging has led to quantitative uptake studies. This method has shown promise in connection with head injury, the quantitation of cardiac ventricular volume, myocardial uptake, and placental uptake. Techniques for such measurements in vivo are being developed. Research on improved collimator design, radiation detectors, new imaging modes, and theories of image recording and data processing for radionuclide scanning and diagnostic radiographic procedures is reported. (CH)

**28330** (IEA-362) PREPARATION OF HIGH-QUALITY IODINE-125-LABELED PITUITARY LUTEINIZING HORMONE FOR RADIOIMMUNOASSAY. Pinto, H.; Wajchenberg, B. L.; Higa, O. Z.; de Toldo e Souza, I. T.; Werner, R. S.; Pieroni, R. R. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov 1974. 20p. Dep. NTIS (US Sales Only) $4.00.

High quality pituitary luteinizing hormone labeled with $^{125}I$ was obtained after separating out the more heavily iodinated fractions, through starch gel electrophoresis, using the cathodal component (fraction 1) which was further purified on Sephadex G 100, with the obtention of an almost pure $^{125}I$-LH preparation, presenting excellent immunoreactivity and low levels of damage on incubation in plasma. The quality control of the steps of the technique was done with plasma coated talc (200 mg) which compared favorably, as for indicating undamaged labeled LH, with the more time consuming chromatoelectrophoresis. (auth)

**28331** (INIS-mf-1628, pp 5) NEW 113m-INDIUM-LABELLED RADIOPHARMACEUTIC AGENTS FOR THE SCANNING OF ORGANS. Bozduganov, A.; Kolarova, T.; Uzunov, I., Popova, M. 1973. (In Bulgarian).

From 3rd national conference on radiology and radiobiology; Plovdiv, Bulgaria (1 Nov 1973).

Published in summary form only. Abstract available in English.

In third national conference on radiology and radiobiology. Abstracts. (Ministerstvo na Narodnoto Zdrave, Sofia (Bulgaria); Meditsinska Akademiya, Sofia (Bulgaria); Nauchno Druzhestvo na Rentgenolozite i Radiolozite, Sofia (Bulgaria). Sektsiya po Radiologiya).

A report is made of new radiopharmaceutic agents produced for the needs of the medical practice and for research work. The labelling technique is described. By means of radiochromatography a very high rate of radionuclide binding with the labelled compound was registered. Cysteamine and methionine were successfully labelled with radioactive indium (113 m-indium). The new radiopharmaceutic compounds have serious advantages because their usage for organ scanning reduces the radiation risk, permits dynamic studies and improves the information received. A very good visualization of the liver, cardiac chambers, kidneys, great blood vessels, bone marrow, placenta, etc., was obtained by using them. Proceeding from detailed experimental and clinical investigations inferences are drawn on the advantages offered by these new radiopharmaceutic agents. (auth)

**28332** (INIS-mf-1628, pp 7) LABELLING OF SOME AMINO ACIDS WITH 113 m-INDIUM IN VIEW OF THEIR USE IN SCINTIGRAPHIC PRACTICE. Popova, M.; Uzunov, I. 1973. (In Bulgarian).

From 3rd national conference on radiology and radiobiology; Plovdiv, Bulgaria (1 Nov 1973).

Published in summary form only. Abstract available in English.

In third national conference on radiology and radiobiology. Abstracts. (Ministerstvo na Narodnoto Zdrave, Sofia (Bulgaria); Meditsinska Akademiya, Sofia (Bulgaria); Nauchno Druzhestvo na Rentgenolozite i Radiolozite, Sofia (Bulgaria). Sektsiya po Radiologiya).

Efforts were directed toward labelling some amino acids with radioactive indium (113 m-indium) because of their amphoteric properties and complex-formation capacity with metal cations. Investigations were carried out with fatty and aromatic amino acids selected so as to have different functional groups: monoaminocarbonic (DL-norvaline, DL-isovaline and methionine), aminodicarbonic (asparagic and glutamic acids and their respective amides), cyclic (phenylalanine and histidine) and aromatic (hippuric and paraaminobenzoic) acids. The method employed was that of labelling by direct introduction of 113 m-In $Cl_3$ in the amino-acid solution at different pH (pH 2-4 and pH 7-8). A high binding rate of 113 m-indium with amino acids was demonstrated by thin layer chromatography. The organ distribution of labelled compounds was followed up by scintigraphic examination of different organs in experimental animals (rabbits). (auth)

**28333** (INIS-mf-1628, pp 58) DISTRIBUTION OF METHIONINE 75-SELENIUM IN ANIMALS WITH EXPERIMENTAL ATHEROSCLEROSIS RECEIVING PROTEIN HYDROLYSATE TREATMENT. Popdimitrov, I.; Demireva, K. 1973. (In Bulgarian).

From 3rd national conference on radiology and radiobiology; Plovdiv, Bulgaria (1 Nov 1973).

Published in summary form only. Abstract available in English.

In third national conference on radiology and radiobiology. Abstracts. (Ministerstvo na Narodnoto Zdrave, Sofia (Bulgaria); Meditsinska Akademiya, Sofia (Bulgaria); Nauchno Druzhestvo na Rentgenolozite i Radiolozite, Sofia (Bulgaria). Sektsiya po Radiologiya).

Investigations were carried out in rabbits and guinea pigs with experimental atherosclerosis induced by feeding them diets rich in cholesterol. The animals were then treated with protein

hydrolysate "Hydroprot". Radioisotope was injected in a dose of 5 c/kg bodyweight and two hours later the animals were killed. The distribution of methionine 75-selenium in the internal organs was followed up. Methionine incorporation was much greater in treated that in control (untreated) animals. (auth)

**28334** STUDIES IN CALCIUM ABSORPTION: INITIAL ENTRY OF CALCIUM INTO THE GASTROINTESTINAL TRACT IN HYPERPARATHYROIDISM AND IN A CASE OF RENAL TUBULAR ACIDOSIS. Barzel, U. S.; Hart, E. (Montefiore Hospital, Bronx, NY). Nephron; 10: 174-187(1973).

Gastrointestinal (GI) absorption of radiocalcium was measured by the application of a computerized deconvolution technique to data obtained by external arm counting. When compared to normals, hyperparathyroid subjects displayed an exaggerated rate of initial entry of calcium into the GI tract. Total tracer absorbed was also increased. A similar increase in the rate of initial entry of calcium and total calcium absorbed from the GI tract was found in a non-hyperparathyroid subject with distal tubular acidosis of the adult type. It is concluded that in addition to the abnormal function of renal tubular cells in the handling of hydrogen ion there may be in this case, and possibly in others with renal tubular acidosis, an abnormality in the handling of calcium by the GI cells. (auth)

**28335** DEVELOPMENT AND STANDARDIZATION OF RADIOIMMUNOASSAYS FOR PROSTAGLANDINS E, F, AND A. Auletta, R. M.; Zusman, R. M.; Caldwell, B. V. (Yale Univ., New Haven). Clin. Chem.; 20: No. 12, 1580-1587(Dec 1974).

Detailed procedures are described for the following: preparation and characterization of tritium-labeled antibodies; collection and handling of samples; extraction and chromatography; establishment of stable assay conditions; and validation of the method. (HLW)

**28336** RADIOIMMUNOASSAY OF URINARY ANTIDIURETIC HORMONE IN MAN: STIMULATION-SUPPRESSION TESTS. Fressinaud, P.; Corvol, P.; Menard, J. (Univ. of Angers, France). Kidney Int.; 6: No. 3, 184-190(1974).

Urinary vasopressin (AVP) has been measured in human beings by a sensitive and reproducible radioimmunoassay. An orally administered water load (15 ml/kg) in dehydrated normal subjects increases C/sub $H_2O$/ from −1,4 +- 0,1 to 2,5 +- 0,6 ml/min while urinary AVP decreases from 7,82 +- 1,56 to 2,69 +- 0,40 ng/2 hr. Infusion of hypertonic saline decreases C/sub $H_2O$/ from −1,8 +- 0,3 to −2,2 +- 0,3 ml/min and increases urinary AVP from 8,24 +- 2,75 to 20,28 +- 1,94 ng/2 hr. The correlation between all the observed values for C/sub $H_2O$/ and urinary AVP is highly significant (r equals −0,66, N equals 26, P less than 0,001). The correlation between plasma osmolality and urinary AVP is also significant (r equals 0,62, N equals 26, P less than 0,001). According to this equation, AVP begins to appear in urine for a plasma osmolality of 275,2 mOsm/kg. During infusion of hypertonic saline, plasma renin (PRA) and plasma aldosterone (PA) have been measured by radioimmunoassays. While hypertonic saline infusion stimulates vasopressin release, it decreases PRA and PA. AVP excretion as measured by radioimmunoassay of urinary AVP responds to alterations in plasma osmolality which affect AVP release, and is an effective and precise means of assessing neurophyseal function in man. Variations in renin secretion and AVP release are dissociated during hypertonic saline load. (auth)

**28337** RADIOACTIVE TRACERS IN THE DIFFERENTIAL DIAGNOSIS OF PULMONARY EMBOLISM. Wagner, H. N. Jr.; Strauss, H. W. (Johns Hopkins Medical Institutions, Baltimore). Prog. Cardiovas. Dis.; 17: No. 4, 271-282(1975).

Perfusion lung scanning and regional ventilation measurements performed together, then can be of considerable value in aiding the alert clinician confirm or refute his working diagnosis of pulmonary embolism. Once the diagnosis is established, the clinician may follow the patients course, determine whether new embolization is occurring in spite of therapy, or if the patient is improving. New techniques are being evaluated to increase the specifity of lung scanning utilizing radiopharmaceuticals that label clots in vivo, or radioimmunoassay of substances such as fibrinopeptides that indicate the presence of intravascular clotting. Application of these techniques in conjunction with ventilation and perfusion imaging to the patient with an abnormal perfusion examination will further aid in the differential diagnosis of abnormal perfusion. (auth)

**28338** RADIOIMMUNOASSAY OF PLASMA TESTOSTERONE. Forti, G.; Pazzagli, M.; Calabresi, E.; Fiorelli, G.; Serio, M. (Univ. of Florence). Clin. Endocrinol. (Oxford); 3: 5-17(Jan 1974).

A radioimmunoassay for the determination of testosterone in human plasma is described. After extraction from plasma, testosterone is separated by paper chromatography. The radioimmunoassay is performed using an antiserum to testosterone-3-oxime-rabbit serum albumin and a saturated solution of ammonium sulphate is used for separation. The reliability criteria of the method in terms of precision, accuracy, sensitivity, and specificity have been evaluated. The mean level of testosterone in plasma samples from nineteen normal men (age range 16 to 73 years) is 527 ± 226 (±SD) ng/100 ml. In ten normal ambulatory females (in the second phase of the cycle) aged 19 to 35 years the mean plasma testosterone is 27.8 ± 10.6 (± SD) ng/100 ml. In twenty-four impotent men (aged 18 to 50) the testosterone level is 431 ± 191 (mean ± SD) ng/100 ml. These values are not significantly different from normal subjects. Lastly, the testosterone levels found in a few cases of male hypogonadism are reported. (auth)

**28339** CLINICAL EVALUATION OF TUMOR SCANNING. Suzaki, K. Jpn. J. Clin. Radiol.; 19: No. 6, 427-433(Jun 1974). (In Japanese).

**28340** DIFFERENTIAL DIAGNOSTICS OF MEDIASTINAL ADENOPATHIES THROUGH RADIOISOTOPES. Carratu, L.; Salvatore, M.; Sonaglioni, F. (Univ., Naples). Arch. Monaldi Tisiol. Mal. Appar. Respir.; 28: 210-232(1973). (In Italian).

With the employment of radioisotopes it is now possible to make a diagnostic exploration of mediastinal adenopathies through two main types of methodologies: adenoscintigraphy and positive oncoscintigraphy. The authors have conducted a study on 86 patients with mediastinal adenopathies of different etiology by using three positive indicators: $^{75}Se$; $^{197}Hg$; and $^{67}Ga$. Findings obtained have proved, especially for the $^{67}Ga$, a nearly constant positiveness of fixing of adenopathies having neoplastic nature. (auth)

**28341** METHODS FOR THE EVALUATION OF KIDNEY FUNCTION WITH RADIOISOTOPES IN CHILDREN. Stoppoloni, G. (Univ., Naples). Pediatria (Naples); 82: No. 3, 360-375 (31 Oct 1974). (In Italian).

The author briefly reviews those tests employing radioisotopes which are most frequently used in pediatric ages (renogram, clearances, scintigraphy, etc.). The author stresses the harmlessness of these techniques which give a lesser irradiation than the classical x-ray examinations, and the usefulness for the diagnosis and the prognosis of the data that can be obtained through these means. (auth)

**28342** RADIO-IMMUNIZATION DETERMINATION: PRINCIPLES OF ESTIMATION METHODS AND APPLICATION POSSIBILITIES. Goedemans, W. T. (Philips-Duphar N. V., Petten (Netherlands). Cyclotron en Isotopen Lab.). Atoomenerg. Haar Toepass.; 17: No. 6, 140-144(Jun 1975). (In Dutch).

Historical aspects of radioimmunization are reviewed, especially the use of isotopic tracers, both $\beta$ and $\gamma$ emitters. Ingredients of tracer marking techniques are defined, including the ability to separate marked compounds from free tracer. Clinical chemical features of marked substances are discussed, and reaction rate problems in samples including hormones, antibodies, serum and cell membranes. Separation methods are classified as radioactive or nonradioactive, or immune or non-immune. Specific assay methods include electron spin resonance, fluorescence, radioimmunoassay and enzymeimmuno assay. Separation techniques listed involve various chromatographic, adsorption and precipitation techniques. A number of applications discussed include blood transfusion in hepatitis patients, vitamin B(12) studies, fertility research, carcino-embryonic-antigen and diagnostic uses for thyroid gland growth, sugar diabetes and hypertension. (NL)

**28343** SCINTIGRAPHY OF BONE IN BENIGN DISEASES OF THE SKELETON. Hermann, H. J.; Lochmann, U. (Freie Univ. Berlin (F. R. Germany). Strahleninstitut und -klinik). Roentgen Bl.; 28: No. 5, 199-206(May 1975). (In German).

The physiologic and pharmacologic basis of scintigraphy of bone and the various techniques of examination are discussed. Results in 339 patients suffering from benign diseases of bone and the indications for scintigraphy are given. (GE)

**28344** CLINICAL APPLICATION OF IODINE 123 WITH SPECIAL CONSIDERATION OF RADIONUCLIDE PURITY, MEASURING ACCURACY, AND RADIATION DOSE. Hermann, H. J.; Ammon, J.; Winkel, K. zum; Haubold, U. (Freie Univ. Berlin (F. R. Germany). Strahleninstitut und -klinik). Fortschr. Geb. Roentgenstr. Nuklearmed.; 122: No. 5, 456-461(May 1975). (In German).

Iodine-123 is a nearly ideal radionuclide for thyroid imaging. The production of $^{123}I$ requires cyclotrons or accelerators. The production of multicurie amounts of $^{123}I$ has been suggested through the use of high-energy accelerators (> 60 MeV). Most of the methods for the production of $^{123}I$ using a compact cyclotron

result in contamination with f.e. $^{124}I$ reduces the spatial resolution of imaging procedures and increases the radiation dose to the patient. The radiation dose has been calculated for three methods of production. The contamination with $^{124}I$, $^{125}I$, and $^{125}I$ result in comparable radiation dose of $^{131}I$, provided that the time between production and application is more than four half-life-times of $^{123}I$. (GE)

**28345** MEASUREMENT OF HUMAN PLASMA RENIN SUBSTRATE CONCENTRATION BY ANGIOTENSIN I RADIOIMMUNOASSAY. A Discussion of Methodical Problems. Bluemel, A.; Oelkers, W. (Freie Univ. Berlin (F.R. Germany). Abt. fuer Innere Medizin mit Schwerpunkt Endokrinologie). Z. Klin. Chem. Klin. Biochem.; 12: No. 10, 453-458(Oct 1974).

Normal mean values of plasma renin substrate concentration reported in the literature vary widely (between 340 and 2,286 μg/l angiotensin I-equivalents). Our own results suggest that plasma renin substrate concentration in healthy men (2,283 ± 410 μg/l angiotensin I-equivalents) is higher than so far believed. The method described still measures plasma renin substrate values that are 7% too low, owing to residual angiotensinase activity. During incubation of diluted plasma with human renin and inhibitors of angiotensinases and converting enzyme, only angiotensin I is formed. Angiotensin II is undetectable. We found considerable differences in the angiotensin I content between 3 different standard preparations investigated. Lack of an accurate angiotensin I standard and insufficient inactivation of angiotensinase seem to be the most important reasons for large differences between normal mean renin substrate-measurements from laboratory to laboratory. Methodical problems of substrate measurement are discussed and illustrated by experimental examples in the paper. (GE)

**28346** "IN VIVO" AND "IN VITRO" REGULATION BY IODIDE OF THYROGLOBULIN IODINATION AND THYROXINE SYNTHESIS. Gavaret, J. M.; Pommier, J.; Deme, D.; Julien, M. F.; Nunez, J. (Institut National de la Sante et de la Recherche Medicale (INSERM), 94-Bicetre (France). Unite de Recherche sur la Glande Thyroide et la Regulation Hormonale). Horm. Metab. Res.; 7: No. 2, 166-172(Mar 1975).

Thyroglobulin iodination and thyroid hormone formation were studied as a function of iodide concentration both in vivo and in vitro. The studies were performed in vivo using rats equilibrated with iodide ($^{127}I$ labelled with $^{125}I$). Double labelling experiments were also performed using tracer $^{131}I$ injected with the last dose of $^{127}I$ at equilibrium. In vitro experiments were performed using purified thyroid peroxidase, non iodinated goiter thyroglobulin, an $H_2O_2$ generating system, and increasing iodide concentrations. In vitro as in vivo iodide, present in high concentration inhibited thyroglobulin iodination. Both in vitro and in vivo inhibition were only transient, and was no longer observed when the iodide concentration decreased. In these respects results from in vivo and in vitro experiments agreed with the classical Wolff-Chaikoff effect. Hormone formation was also severely inhibited as iodide concentration was increased. Thus additional evidence is provided which demonstrates the existence of at least one intrinsic thyroidal mechanism, at the level of thyroid peroxidase, which responds to variations in the iodide concentration both for total iodination of thyroglobulin and for coupling of iodotyrosine residues to thyroid hormones. (GE)

**28347** PROTRIPTYLINE INDUCED INHIBITION OF THE IN VIVO $^3H$-NORADRENALINE SYNTHESIS FROM $^3H$-L-DOPA IN THE RAT BRAIN. Nielsen, M.; Eplov, L.; Scheel-Krueger, J. (Saint Hans Hospital, Roskilde (Denmark). Central Lab.). Naunyn-Schmiedebergs Arch. Pharmakol.; 285: No. 1, 15-28(1974).

$^3H$-L-Dopa was given i.p., after a peripheral decarboxylase inhibitor (Ro-4-4,602; 50 mg/kg), to male Wistar rats and the effect of protriptyline pretreatment (10 mg/kg, 30 min.) on the formation and metabolism of the brain $^3H$-catecholeamines, dopamine and noradrenaline and all their metabolites was investigated. Protriptyline produced a strong decrease of labelled noradrenaline and its metabolites 60 and 120 min. after $^3H$-L-Dopa. $^3H$-noradrenaline was also decreased 30 and 45 min. after $^3H$-L-Dopa. In rats and mice the pretreatment with protriptyline (10 mg/kg, 30 min.) induced also a significant decrease in brain $^3H$-noradrenaline but not $^3H$-dopamine synthesized from $^3H$-L-tyrosine. Protriptyline produced no effect on endogenous dopamine and noradrenaline in the rat or mouse brain. The findings strongly indicate that the acute treatment with protriptyline inhibits the $^3H$-noradrenaline formation from $^3H$-L-Dopa. (GE)

**28348** SEPARATION OF THE EFFECTS OF TRANSMUTATION AND RADIATION AFTER INCORPORATION OF RADIONUCLIDES INTO DNA. Hamann, H. J.; Irskens, M. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Hannover (F. R. Germany). Inst. fuer Strahlenbotanik; Technische Univ. Hannover (F. R. Germany). Inst. fuer Biophysik). Radiat. Environ. Biophys.; 11: No. 4, 327-340(Mar 1975). (In German).

Among the various methods for studying the relative effects of transmutation and radiation of incorporated nuclides, simulation of beta radiation by external gamma exposure is of practical importance. Self-irradiation and mutual irradiation of the labeled cells cannot be neglected in any case. Furthermore, additional hypothetical and experimental problems may arise from using either external beta radiation or different isotopes of an element. By means of external gamma irradiation on the other hand, this being equivalent to the internal beta radiation from a microdosimetrical point of view, the radiation effect of the nuclide alone can be observed without any modification of other experimental parameters. To determine such equivalent gamma radiation for labeled cell nuclei of Vicia faba roots, the Monte Carlo Method was applied to the beta spectra of $^{32}P$, $^3H$, $^{14}C$, and $^{131}I$, to the energy-dependent LET, and to different cell diameters. The existence of secondary particle equilibrium inside the nuclei during gamma exposure was assumed. For certain radionuclides and cell sizes it is possible to calculate gamma spectra which induce energy in the nuclei similar to those caused by the beta particles originating in the nuclear DNA. (GE)

**28349** PANCREAS SCAN. Schneider, C.; Montz, R. (Hamburg Univ. (F. R. Germany). Abt. fuer Nuklearmedizin). Radiologe; 15: No. 5, 203-209(May 1975). (In German).

A review is given that covers ten years experience with pancreas scans. The diagnostic value of $^{75}Se$ Methionine scan is limited because of the lack of organ specifity of this substance. There is no improvement by pharmacological stimulation of the pancreas or subtraction techniques of the $^{75}Se$-activity in the liver. In the early phase after the injection of $^{75}Se$ the distribution is more favorable for the pancreas compared to liver and intestine. Four descriptive terms are in use: normal, spotted, organ defect, and lack of uptake. There are no specific signs for pancreatitis, carcinoma, or exocrine dysfunction. Considering these limited factors, the use of pancreas scans is valuable to exclude pancreatic diseases. (GE)

**28350** CONTRIBUTION ON THE AMELIORATION OF THE FOCAL DOSE DETERMINATION IN THE SMALL PELVIS. Sager, W. D.; Hackl, A.; Ranegger, W. (Graz Univ. (Austria). Abt. fuer Strahlentherapie). Strahlentherapie; 149: No. 5, 471-475 (May 1975). (In German).

An easily applied auxiliary method used to register exactly the topographic relations on horizontal sections in the small pelvis is indicated. Only the body contour, pelvis pictures on two planes, diapositives with the corresponding pictures of the cross section, and a photographic enlarger are needed. A sagittal tomogram in the median plane, and for radium therapy, the localization pictures on two planes are other helps. (GE)

**28351** THERAPY-VERIFICATION-FILM FOR THE FIELD CONTROL DURING $^{60}Co$ RADIOTHERAPY. Kutzner, J.; Manczak, G. (Mainz Univ. (F. R. Germany). Inst. fuer Klinische Strahlenkunde). Strahlentherapie; 149: No. 5, 484-487(May 1975). (In German).

The therapy-verification-film RP/V X-omat Kodak is a gamma sensitive film. Because of its relative insensitivity to radiation of about 25-150 R, it presents a density of S = 0.7 to S = 3.0 and is easily exploitable. Therefore, it is useful in field controls during radiotherapy, especially for the mantel field technique. It represents a good complement to the gamma-sensitive film RPTL. (GE)

**28352** NEW PRINCIPLES AND THEORIES FOR IMPROVING ANGIO-CINE-DENSITOMETRY. I. The Physical Principles of Quotient Densitometry. Vanselow, K.; Heuck, F. (Kiel Univ. (F. R. Germany). Inst. fuer Angewandte Physik; Katharinenhospital, Stuttgart (F. R. Germany). Zentral-Roentgeninstitut). Fortschr. Geb. Roentgenstr. Nuklearmed.; 122: No. 5, 453-456(May 1975). (In German).

The physical basis of quotient densitometry is described. All stages are discussed, beginning with the production of the X-rays, their attenuation by the patient, their effect on the radiographic film, and the evaluation of the film by projection and its measurement by a photocell in a Wheatstone bridge. Two values were obtained, one consisting of the signal together with background, and the other of background alone. By an analysis of the relationships of these measurements, obtained from specially separated points on the radiograph, it is possible to eliminate artefacts to a large extent. (GE)

**28353** BONE SCANNING. Greenfield, L. D. (City of Hope National Medical Center, Duarte, CA); Bennett, L. R. Am. Fam. Physician.; 11: No. 3, 84-89(Mar 1975).

Scanning is based on the uptake of a nuclide by the crystal lattice of bone and is related to bone blood flow. Cancer cells do

not take up the tracer. Normally, the scan visualizes the highly vascular bones. Scans are useful and are indicated in metastatic bone disease, primary bone tumors, hematologic malignancies, and some non-neoplastic diseases. The scan is more sensitive than x rays in the detection of malignant diseases of the skeleton. (auth)

**28354** PHYSIOLOGY AND GENETICS OF REPRODUCTION. Part A. Proceedings of the 13th International Symposium Held in Salvador, Brazil, December 3–7, 1973. Coutinho, E. M.; Fuchs, F. (eds.). New York; Plenum Press (1974). 434p. (CONF-731222-PA).

A separate abstract was prepared for one chapter. (CH)

*For abstract of individual chapter see: 28295.*

**28355** PHYSIOLOGY AND GENETICS OF REPRODUCTION. Part B. Proceedings of the 13th International Symposium Held in Salvador, Brazil, December 3–7, 1973. Coutinho, E. M.; Fuchs, F. (eds.). New York; Plenum Press (1974). 464p. (CONF-731222-PB).

A separate abstract was prepared for one chapter. (CH)

*For abstract of individual chapter see: 28356.*

**28356** HORMONE PATTERNS IN EARLY HUMAN GESTATION. Mishell, D. R. Jr.; Thorneycroft, I. H.; Nagata, Y.; Murata, T.; Nakamura, R. M. (Univ. of Southern California, Los Angeles). pp 371-384 of Physiology and Genetics of Reproduction. Part B. Coutinho, E. M.; Fuchs, F. (eds.). New York; Plenum Press (1974).

From 13th international symposium on physiologic and genetic aspects of reproduction; Salvador, Brazil (2 Dec 1973). See CONF-731222--PB.

Accurate measurement of the low concentration of gonadotropins and steroid hormones present in human serum has been made possible by the development of sensitive radioimmunoassay (RIA) techniques. With the use of RIA FSH and LH, progesterone and 17OH-progesterone have been previously measured in early normal pregnancy. In order to determine the daily pattern of hormone levels in early normal pregnancy, gonadotropins as well as steroid hormone levels were measured in serum samples obtained daily from three women from the time of the last menstrual period prior to conception throughout the first few months of gestation. To further identify the steroid hormone pattern in early normal pregnancy, concentrations of estradiol, progesterone, and 17OH-progesterone were measured in individual serum samples obtained from a group of 158 women with apparently normal gestations who subsequently had therapeutic abortions. (auth)

**28357** 20 MIN $^{99m}$Tc THYROID UPTAKE. Goebel, R.; Leb, G.; Eber, O. (Graz Univ. (Austria). Medizinische Klinik). Med. Klin. (Munich); 70: No. 4, 154-157(Jan 1975). (In German).

The 20 min $^{99m}$Tc thyroid uptake compares favorably with the more time consuming 24 h $^{131}$I uptake because it results in a lower radiation dose to the thyroid gland. The reliability of both methods is nearly the same. In all conditions in which the $^{131}$I uptake is altered, a similar deviation of the $^{99m}$Tc uptake has been found. A single exception are patients treated with antithyroid drugs (together with thyroid hormones), who show frequently an elevated $^{99m}$Tc uptake (in contrast to the $^{131}$I uptake). Prognostic conclusions have been drawn by other authors from the $^{99m}$Tc uptake in similar cases. (GE)

**28358** METABOLISM OF THE PHOSPHATIDYLGLYCEROL MOLECULAR SPECIES IN ESCHERICHIA COLI. Kito, M.; Ishinaga, M.; Nishihara, M.; Kato, M.; Sawada, S.; Hata, T. (Kyoto Univ. (Japan). Research Inst. for Food Science; Kyoto Univ. of Education (Japan). Dept. of Chemistry). Eur. J. Biochem.; 54: No. 1, 55-63(May 1975).

The fractionation, turnover and biosynthesis of the phosphatidylglycerol molecular species of Escherichia coli were studied. Monoacetyldiglycerides derived from phosphatidylglycerol were separated into five subfractions: cis-vaccenyl-palmitoleyl, cis-vaccenyl-cis-vaccenyl, palmityl-palmitoleyl, palmityl-cis-vaccenyl and the desaturated molecular species on a silica gel plate impregnated with silver nitrate. Individual molecular species had different turnover rates. The palmityl-cis-vaccenyl species was metabolized faster than the others. Desaturated species were rather stable. Various phosphatidylglycerol molecular species were synthesized in the presence of sn-glycerol 3-phosphate, palmityl-CoA, palmitoleyl-CoA, cis-vaccenyl-CoA and CTP by the E. coli membrane particulate fraction. When only the proportion of palmityl-CoA among the three acyl-CoAs was increased, the molecular species containing the palmityl residue were increased. Similar results were obtained with the other acyl-CoAs. However, a temperature-sensitive incorporation of unsaturated and saturated fatty acids into phosphatidylglycerol molecular species was observed with no change in the proportions of the three acyl-CoAs, completely reflecting the in vivo unsaturated/saturated ratio. (GE)

**28359** NATURAL PRODUCTS FROM FUNGI. XXV. Biosynthesis of the Seco-Anthraquinones Geodin and Dihydrogeodin from Emodin. Fujimoto, H.; Flasch, H.; Franck, B. (Muenster Univ. (F. R. Germany). Organisch-Chemisches Inst.). Chem. Ber.; 108: No. 4, 1224-1228(1975). (In German).

Feeding of biosynthetically prepared [u-$^{14}$C]emodin([u-$^{14}$C]-2) to surface cultures of Aspergillus terreus yielded radioactive geodin (5) and dihydrogeodin (3c) with significant incorporation rates. Thus it is proven that these two chlorine containing fungus metabolites are seco-anthraquinones formed similarly as the ergochromes from emodin by oxidative ring cleavage. (GE)

**28360** PHOSPHORUS-31 AS A NUCLEAR PROBE FOR MALIGNANT TUMORS. Zaner, K. S.; Damadian, R. (State Univ. of New York, Brooklyn). Science; 189: No. 4204, 729-731(29 Aug 1975).

Phosphorus-31 may prove useful as an additional nucleus for detecting malignancy by nuclear magnetic resonance. The spin-lattice relaxation times for phosphorus-31 determined by a saturation technique employing a $90^0$-tau-$90^0$-tau-$90^0$...,pulse sequence were significantly higher for two rat malignancies, Novikoff hepatoma and Walker sarcoma, and the Crocker sarcoma of mice than for normal liver, muscle, brain, kidney, and intestine tissues. No individual measurement of malignant tissues overlapped any of the measurements of normal tissues, and the probabilities of insignificance ranged from 0.029 for Crocker sarcoma to 0.000184 for Novikoff hepatoma. The phosphorus-31 nucleus, because of its strategic placement in the nucleic acid molecule, may be useful as a new probe for exploring the mechanism of carcinogenesis. The results call attention to another nucleus that may prove valuable for nuclear magnetic resonance equipment aimed at the detection of internal malignancies in humans. (auth)

**28361** CELL COMPOSITION OF THE RED PULP OF MICE. I. Autoradiographic Investigations with $^3$H-Thymidine in Thin Sections. Yamashita, K.; Helpap, B. (Bonn Univ. (F. R. Germany). Pathologisches Inst.). Virchows Arch. Abt. B.; 16: No. 4, 331-346(1974). (In German).

A cytokinetic and morphological cell analysis was performed, with autoradiograms of thin sections in red pulp of untreated mice. The following cells could be differentiated in the thin preparations: (1) basophilic blasts (large and small); (2) erythroblasts (basophilic, poly- and orthochromatic); (3) lymphocytes; (4) plasma cells; (5) reticulum cells (without and with phagocytosis); (6) endothelial cells; (7) myelopoietic cells; and (8) megakaryocytes. Erythropoiesis essentially takes place in the interfollicular zones while myelopoiesis predominates in the subcapsular and peritrabecular zones. The autoradiographic study suggests that in the interfollicular zone, basophilic blasts and erythroblasts can be classified as locally arising cells, while small lymphocytes, reticulum cells without and with phagocytosis (macrophages) can be regarded as migrating cells. (GE)

**28362** IMMUNOLOGICAL COMPARISON OF BASIC ENCEPHALITOGEN AND HISTONE F2A1. Bustin, M.; Teitelbaum, D.; Webb, C. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Chemical Immunology). Eur. J. Biochem.; 53: No. 2, 615-621 (May 1975).

3 figs.; 4 tabs.; 43 refs.

The extent of immunological cross-reaction between basic encephalitogen and histone F2A1 on both the humoral antibody level and on the cellular level was established. The extent of humoral cross-reaction was tested by direct complement fixation employing both antihistone F2A1 and antisera to basic encephalitogen, by inhibition of complement fixation, by radioimmunoassay, and by passive cutaneous anaphylaxis. The data obtained failed to reveal immunological cross-reaction between the proteins on the humoral antibody level. The extent of cross-reaction at the cellular level was tested by the lymphocyte stimulation technique in rabbits and guinea pigs, by inhibition of lymphocyte stimulation and by delayed hypersensitivity skin reactions. It is concluded that the immunological studies provide limited evidence that the two proteins share antigenic determinants. (GE)

**28363** QUANTITATION OF IgE BY MEANS OF A MODIFIED RADIAL IMMUNODIFFUSION METHOD IN COMPARISON WITH THE RADIOIMMUNOSORBENT TEST (RIST). Wiedermann, G.; Stemberg, H.; Kraft, D.; Ambrosch, F.; Schadlbauer, B.; Jarischko, E. (Vienna Univ. (Austria). Inst. fuer Hygiene; Vienna Univ. (Austria). 2. Hautklinik). Z. Immunitaetsforsch., Exp. Klin. Immunol.; 147: No. 4, 366-371(1974). (In German).

2 tabs.; 10 refs.

Serum IgE was quantified by means of a modified radial immunodiffusion technique (RID). To improve visibility of precipitin bands a staining procedure with DOPA was applied. Pretreatment of sera with dextransulfate proved necessary in order to avoid unspecific ring formation in the agar gel. In comparison

with the RIST it turned out that sera containing less than 500 I. U. IgE/ml did not produce precipitin bands with this method. Sera containing 500-999 I. U. IgE/ml occasionally exhibited positive results with the RID technique, whereas sera with more than 1,000 I.U./ml were regularly positive. In its present form the RID may be used as screening method for sera with higher IgE levels. Within the above mentioned limits the IgE levels calculated by means of the RID-test roughly corresponded to the values determined by the RIST. (GE)

**28364** STUDIES ON THE DIRECT RADIOIMMUNOLOGICAL DETERMINATION OF TRIIODOTHYRONINE IN SERUM. Meinhold, H.; Wenzel, K. W. (Freie Univ. Berlin (F. R. Germany). Nuklearmedizinische Abt.). Z. Klin. Chem. Klin. Biochem.; 12: No. 11, 477-486(Nov 1974). (In German).

6 figs.; 7 tabs.; 38 refs.

The production of highly specific antisera for $T_3$ and the development of a sensitive radioimmunological procedure for the direct measurement of $T_3$ in serum is described. Anti-$T_3$ sera were produced by immunizing rabbits with conjugates of $T_3$ and bovine albumin, human albumin, and ovalbumin. The various antisera produced showed very little variance in quality and could be used for the direct radioimmunological determination of serum-$T_3$ with final dilutions between 1:60,000 and 1:300,000. Binding of $T_3$ to thyroid-hormone-binding serum proteins was inhibited by 8-anilinonaphthalene-1-sulfonic acid. This compound showed better inhibition properties than merthiolate and sodium salicylate. The separation of free and bound hormone was performed by the double antibody technique. The separation by dextran-coated charcoal and ion-exchange resin leads to a decrease of the antibody-bound activity. The validation of the method used was tested by serial dilutions of sera, recovery experiments, and by comparing the serum-$T_3$ values measured in ethanol extracts with those values obtained by the direct measurement in unextracted serum. The lower limit of detection was approximately 0.18 nmol/l serum. The variation coefficient for the intraassay reproducibility was between 4.3 and 6.1% for the interassay reproducibility between 7.7 and 13.9%. Measured mean $T_3$ concentrations for various thyroid states are given. (GE)

**28365** EXPERIENCE WITH THE CONTRAST MEDIUM TELEBRIX 300 IN NEURORADIOLOGY. Kunkel, B. (Muenchen Univ. (F. R. Germany). Abt. fuer Neuroradiologie). Muench. Med. Wochenschr.; 117: No. 12, 487-490(Mar 1975). (In German).

3 tabs.; 17 refs.

Clinical experience with a new triiodized contrast medium (Telebrix 300) in cerebral angiography is reported. In one of its forms, Telebrix is available as the pure methylglucamine salt of the newly developed ioxitalaminoacid in 66% aqueous solution, with an iodine content of 300 mg/ml. The results of the use of Telebrix 300 in 302 patients examined with over 600 single vascular visualisations (direct puncture and catheter angiography) are communicated. Unforeseen incidents with permanent neurological disturbances were not observed. Local and general tolerance of Telebrix 300 is excellent, even after large quantities of the contrast medium (up to 300 ml). (GE)

**28366** CLINICAL RESULTS OF PERFUSION SCINTIGRAPHY OF THE LUNGS WITH $^{99m}$Tc MICROSPHERES. Kampmann, H.; Adam, W. E.; Bargon, G. (Ulm Univ. (F. R. Germany). Dept. Radiologie). Muench. Med. Wochenschr.; 117: No. 15, 619-624(Apr 1975). (In German).

5 figs.; 1 tab.; 19 refs.

Lung scintigrams which had been made with $^{99m}$Tc microspheres in 104 patients were examined, analyzed and compared with the general radiograph of the lungs. Lung perfusion scintigraphy is markedly superior to radiological examination of the lungs in pulmonary embolism, including microemboli, but distinctly inferior in bronchopneumonias. In the other diagnostic questions there is a good agreement between scintigraphic and radiological findings. A critical attitude is taken on the indication for pulmonary scintigraphy. (GE)

**28367** RADIOIMMUNOASSAY FOR METHOTREXATE. Levine, L.; Powers, E. (Brandeis Univ., Waltham, MA). Res. Commun. Chem. Pathol. Pharmacol.; 9: No. 3, 543-554(Nov 1974).

Rabbits and a goat immunized with a methotrexate-hemocyanin conjugate produced antibodies that bind [$^3$H]methotrexate. The goat antibodies were used for the development of a radioimmunoassay for methotrexate. The radioimmunoassay is specific: $10^5$ to $10^6$ times more folic acid, tetrahydrofolic acid, or folinic acid are required to compete effectively with methotrexate for the antibodies to methotrexate. As little as 100 picograms of methotrexate can be detected in the assay. The radioimmunoassay was used to follow the disappearance of methotrexate in the plasma of two patients with malignancies following its intravenous administration. (auth)

# MATERIALS

## Ceramics and Cermets

*Refer also to abstracts 27679, 27903, 28038, 28484, 28486, 28496, 28525, 28546, 28548, 28549, 28559, 28573, 28648, 28650, 28652, 28655, 28698, 29875, 30165, 30168, 30185–30187, 30216, 30229, 30368, and 30369.*

**28368** (AERE-TP-583) GROUND STATE OF TWO-HOLE CENTRES IN OXIDES. Stoneham, A. M.; Pathak, A. P.; Bartram. R. H. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). 1975. 20p. Dep. NTIS (US Sales Only) $4.00.

The nature of the ground state of the V center in ionic oxides, where two holes are trapped by a cation vacancy is discussed. Results of experiments appear to indicate an S = 1 ground state for BeO and $Al_2O_3$ and possibly CaO and ZnO, with S = O in MgO. Simple theoretical arguments suggest S = O. It is shown that a weak admixture of $[0^0\ 0^{2-}]$ configurations into the dominant $[0^-\ 0^-]$ configuration can explain the observations. Quantitative calculations are given for MgO, and suggest the singlet state is lowest by about 30 $cm^{-1}$. (auth)

**28369** (COO-1441-27) STUDY OF THE DEFECT STRUCTURE OF "PURE" AND DOPED NONSTOICHIOMETRIC $CeO_2$. Blumenthal, R. N. (Marquette Univ., Milwaukee, Wis. (USA). Coll. of Engineering). Sep 1975. Contract E(11-1)-1441. 42p. Dep. NTIS $5.25.

Electrical conductivity and thermogravimetric measurements were made on $Ta_2O_5$-doped nonstoichiometric $CeO_2$ (i.e. Ce/sub 1-y/Ta/sub y/O/sub 2-x/) as a function of temperature and oxygen partial pressure. Over a limited range of temperature and nonstoichiometry, the isothermal dependence of the electrical conductivity on nonstoichiometry may be described by the equation sigma equals A + Bx, where A is the electronic conductivity associated with the electronic defects produced by doping $CeO_2$ with $Ta_2O_5$. The electronic conductivity resulting from the nonstoichiometric defect reaction O/sup x/ + 2Ce/sub Ce//sup x/ equals $V_0$ + 2Ce'/sub Ce/ + ½$O_2$(g) is equal to Bx. The ionic conductivity may be described by the relation sigma/sub i/ equals B[y+x]emu'/sub $V_0$/ exp (–E/sub i/kT), and the electronic conductivity by the isothermal expressions sigma/sub e/ proportional to P/sub $O_2$//sup –1/4/ and sigma/sub e/ proportional to x; x less than $3 \times 10^{-2}$. These results are consistent with defect models involving doubly ionized oxygen vacancies. An empirical expression (i.e. DELTA $\overline{H}$/sub $O_2$/ proportional to y/2 or z/4) was obtained relating the dependence of DELTA $\overline{H}$/sub $O_2$/ on the dopant concentration of lower valent foreign cations (e.g. y/2 for Ce/sub 1-y/M/sub y/O/sub 2-y-x/ and z/4 for Ce/sub 1-z/M/sub z/O/sub 2-z/2-x/ where M equals Ca, Sr and M' equals Y, La). (auth)

**28370** (DP-Report-785) GAS FLOWS IN SPOUTING BEDS. Dragon Project. Van Velzen, D.; Flamm, H. J.; Langenkamp, H. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Mar 1972. 24p. Dep. NTIS (US Sales Only) $4.25.

Fluidized bed coating of nuclear fuel particles is a generally adopted technique. The scale of operation is limited so far to batch sizes of a few kg in coating units of up to about 150 mm ID due to the almost entirely empirical approach to the process. Room temperature model experiments are now undertaken in order to enlarge the comprehension of the basic physical parameters. The first observations with respect to gas distribution measurements in a 125 mm ID Dragon-type bed are reported. Various solid materials were used and generally spouting beds were obtained under the experimental conditions. Average gas velocities in the spout and in the annulus were established as a function of axial distance above the gas inlet. Measurements were performed down to 3 cm above the gas inlet (nozzle). Empirical, mathematical expressions for the average gas velocity in the spout and for the total gas volume traveling upward in the spout were developed. The introduced momentum is the main governing parameter for gas distribution, the latter being independent of solids properties. Evidence was obtained that a considerable recirculation of gas takes place in the lower part of the bed. (auth)

**28371** (DP-Report-817) EXPERIENCE GAINED IN THE DRAGON PROJECT WITH THE SNAM PROCESS OF KERNEL MANUFACTURE FOR HTR FUELS. Dragon Project. Facchini, A.; Gallone, S.; Gerontopoulos, P.; Graham, L. W.; Price, M. S. T. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Dec 1972. 26p. Dep. NTIS (US Sales Only) $4.50.

The choice of fabrication route for kernel manufacture at the present time lies between powder agglomeration and gel-supported precipitation. An economic study comparing a typical powder agglomeration process and the SNAM process favors the latter for large-scale production. Experience gained in the Dragon Project with the manufacture and irradiation of HTR fuels with kernels made by the SNAM process is summarized. The irradiation results are reviewed in terms of the general background of information on factors affecting performance. It is noteworthy that no strong influence related to kernel porosity was observed. (auth)

**28372** (ERDA-9) CRITICAL NEEDS AND OPPORTUNITIES IN FUNDAMENTAL CERAMICS RESEARCH. Summary of a Meeting Held at Massachusetts Institute of Technology, January 1975. Ianniello, L. C.; Kingery, W. D.; Readey, D. W. (comps.). (Massachusetts Inst. of Tech., Cambridge (USA)). Apr 1975. 80p. Div. of Physical Research, Washington, DC.

The individual discussions of needs for ceramic science and the topical and general discussions of needs and opportunities of ceramic science represent a substantial concensus reached in a short meeting. The list of topics considered was by no means inclusive, the participants do not represent all possible points of view, and the discussions were necessarily biased by the particular interests of those present. In addition, ceramic science is a very broad subject. It is clear that both the needs and the opportunities for ceramic science are great; and a number of common concerns have been identified. Discussions are included on materials preparation and characterization, models and theories, experimental measurements, properties of oxides, and plausibility of experiments. (JRD)

**28373** (HWS-6595(Rev.4)) SPECIFICATION FOR BORON CARBIDE VIBRATING MIX 100-N REACTOR. Goff, J. M. Jr. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 4 Jan 1973. Contract AT(45-1)-1857. 4p. Dep. NTIS $4.00.

Specifications are presented for pulverized $B_4C$ suitable for vibration packing in fabrication of containers. Requirements are listed for chemical composition, particle size, density, and uniformity. (JRD)

**28374** (INEL-TR-2) INVESTIGATIONS OF THE THERMAL CREEP OF $UO_2$ AND $UO_2$–$PuO_2$ AT HIGH TEMPERATURES. Kummerer, K.; Vollath, D. Translated by C. S. Olsen from Atomwirtsch., Atomtech.; 16: 29-31(1971). 9p. Dep. NTIS $4.00.

Compressive creep of $UO_2$ and $UO_2$–$PuO_2$ samples was studied at stresses up to 5 $kg/mm^2$ and at temperatures from 800 to 2000°C. Creep rate was significantly higher in $UO_2$–$PuO_2$ as compared to $UO_2$ samples. To describe the effects, a mathematical formula was developed and presented. (DLC)

**28375** (JUL-1192) METALLOGRAPHIC STUDY OF THE NIOBIUM-HYDROGEN SYSTEM. Part I. β-Phase Room Temperature Morphologies. Part II. γ, Delta, Zeta, and Epsilon-Phase Precipitation. Schober, T.; Linke, U. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung). May 1975. 19p. Dep. NTIS (US Sales Only) $4.00.

β-phase precipitation in the NbH-system was investigated using optical metallography. Two β-phase morphologies were found: dendritic features at high supersaturations of hydrogen, and plates on $\{100\}_c$ at low supersaturations. The domain structure of the β-phase was investigated using polarized light techniques. The domains were thin plates, typically a few μm thick, on low index planes of the matrix. A geometrical model of the β-phase domain structure was developed that is in good agreement with experimental observations. The important role of coherent domain boundaries is discussed. β-phase crystals were found to cleave easily on $\{110\}_c$. Plastic slip induced slip lines on the surface of β-phase specimens that were compatible with $\{110\}_c$ slip planes. The observation of γ-phase precipitation in interference and polarized light contrast is reported. Characteristic surface deformation effects during the $\beta \rightarrow \gamma$ transformation are described. δ-phase precipitation was investigated in the concentration range from 100 to 200% (= H/Nb). Precipitation occurred on $\{210\}_c$ planes. The accompanying bcc to fcc transformation led to strong plastic deformation in β-phase areas. ζ and ε precipitation did not affect the metallographic appearance of the β-phase domain structure. (auth)

**28376** (KFK-2140) TUNNELING STUDIES ON SUPERCONDUCTING NIOBIUM CARBIDE. Geerk, J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Kern-

physik). Jun 1975. 91p. (In German). Dep. NTIS (US Sales Only) $7.75.

Tunneling diodes of the type NbC/Ox/Au were prepared on zone melted polycrystalline NbC with a $T_c$ of about 7.5°K. A clean surface was produced by chemical preparation methods. A reactance network suitable for the detailed study of the second derivative of the current–voltage characteristics of superconducting tunneling diodes was constructed with low noise and applicability for a wide range of resistance of the tunneling diodes (0.1 Ω - 1 kΩ). For the energy gap $\Delta_0$ of the NbC samples, values of about 1.0 meV were found. The values for $2\Delta_0/KT_c$ were found to be quite close to the BCS prediction of 3.53. In the voltage region above the energy gap, deviations of the measured tunneling characteristics from the BCS theory were detected; they can be explained by the effect of the acoustic phonon density of states of NbC on the effective tunneling density of states. In the optical phonon energy region, no structure in the tunneling density of states was detected. The Eliashberg function $\alpha^2(\omega)F(\omega)$ of NbC was obtained by analysis of the tunneling data using the computer program of McMillan. The coulomb pseudopotential $\mu^*$ was found to be 0.040, lower than the value of 0.1 proposed by Morel and Anderson. This discrepancy may be due to a weakening of the measured function $\alpha^2(\omega)F(\omega)$ in certain energy regions. The possible error in the measured function $\alpha^2(\omega)F(\omega)$ was estimated. The function $\alpha^2(\omega)$ $F(\omega)$ was compared with the phonon density of states $F(\omega)$ of NbC measured by Gompf et al. and the electron-phonon coupling function $\alpha^2(\omega)$ was calculated. $\alpha^2(\omega)$ shows at an energy of 17 meV, which is close to the steep increase of $F(\omega)$, a peak of a width of 4 meV. On the rest of the energy range, $\alpha^2(\omega)$ shows a rather flat behavior. The electron-phonon coupling constant $\lambda$ calculated from the measured function $\alpha^2(\omega)F(\omega)$ was 0.51 compared with the value of 0.64 expected on the basis of $T_c$ and $\Theta_D$. Thus, in NbC mainly the acoustic phonons determine $\lambda$. Weber found for the refractory materials with NaCl-structure a deviation from McMillan's empirical rule for the connection of $T_c$ with the mean force constant of the lattice. The observed energy dependence of $\alpha^2(\omega)$ has only a small influence on the mean square frequency $<\omega^2>$, and therefore this deviation cannot be caused by this energy dependence. (25 fig) (DLC)

**28377** (LA-UR--75-1646) INFLUENCE OF STANDING-WAVE FIELDS ON THE LASER DAMAGE RESISTANCE OF DIELECTRIC FILMS. Newman, B. E.; Gill, D. H.; Faulkner, G. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. Contract W-7405-ENG-36. 19p. (CONF-750730--1). Dep. NTIS $4.00.

From symposium on damage in laser materials; Boulder, Colorado, USA (30 Jul 1975).

The influence of standing-wave electric fields on the damage resistance of dielectric thin films was evaluated for the case of 30-ps laser pulses at 1.06 mu m. Single-layer films of $TiO_2$, $ZrO_2$, $SiO_2$, and $MgF_2$ were deposited by state-of-the-art electron-gun evaporation on BK-7 glass substrates with uniform surface preparation. The film thicknesses ranged from one to five quarter-wave increments. The thresholds for $TiO_2$ films of odd quarter-wave thickness were greater than for even multiples which correlated well with the calculated internal maximum electric fields. Threshold variations for $ZrO_2$ films were apparent but not as distinctly periodic with film thickness. Negligible variations were obtained for $SiO_2$ films, again correlating with electric-field calculations. Results of additional tests allowed comparisons of thresholds for 1) back-and front-surface films for normal incidence; 2) S- and P-polarized radiation at an incidence angle of 60°; and 3) circular and linear polarizations for normal incidence. The thresholds were compared with calculated standing-wave field patterns at various locations in the films. A correlation was generally found between the internal field maxima and the thresholds, but in a few coatings, defects apparently decreased or prevented any correlation. (auth)

**28378** (SAND-75-5444) DIFFUSION AND AGGREGATION OF IMPLANTED Ag AND Au IN A LITHIA–ALUMINA–SILICA GLASS. Arnold, G. W.; Borders, J. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 14p. (CONF-750926-2). Dep. NTIS $4.00.

From international conference on applications of ion beams to materials; Warwick, UK (9 Sep 1975).

Optical extinction and Rutherford backscattering (RBS) techniques were employed to obtain information on the size and spatial distribution of Au- and Ag-colloids in implanted ($Au^+$, $Ag^+$) lithia-alumina-silica glass. The formation of metallic aggregates (colloids), necessary for preparation of a glass-ceramic surface layer, proceeds readily with annealing temperature for Au-implanted samples but not for Ag-implanted material. The optical and RBS spectra show that the particle size and spatial distribution in as-implanted samples are sensitive to sample temperature and ion-beam heating effects, while these parameters for Au-implanted samples are relatively insensitive to temperature and beam current. It is suggested that this behavior is related to differences in the dissolution energies of Ag and Au aggregates. A two-peaked spatial distribution for Ag implanted at room temperature at a dose rate of approximately 1 mu A/$cm^2$ is observed which may result from the trapping of Ag in the compacted damage region of the glass during implantation. (auth)

**28379** (STI/PUB-380(Vol. 2)) THERMODYNAMICS OF NUCLEAR MATERIALS, 1974. Volume II. Proceedings Series. Proceedings of a Symposium Held in Vienna, 21–25 October 1974. (International Atomic Energy Agency, Vienna (Austria)). 1975. 534p. (In Several Languages). (CONF-741030-P2). IAEA $32.00.

Thirty-two papers are included in Vol. II on theoretical models of nuclear fuels, basic phase equilibria of nuclear fuels and basic thermodynamic properties. (JRD)

*For abstracts of individual papers see: 27668, 27669, 27679, 28443–28459, 28496, and 28611–28622.*

**28380** (UCRL-Trans–10907) DYNAMIC BEHAVIOR OF DISCONTINUITIES IN A SOLID MATRIX. Leiber, C. O.; Flajs, G.; Hessenmuller, R.; Wild, R. Translated from Z. Metallkd.; 65: No. 8, 539-541(1974). 14p. Dep. NTIS $4.00.

The dynamic behavior of discontinuities in solid matrixes is described using a hydrodynamic–acoustic formulation based on the assumption that the discontinuities have a spherical shape with a radius which is small compared with the shock slope increase rate. Experiments designed to show that these assumptions are qualitatively correct are described. Powdered W/Al pairs were used in the experiments along with powdered quartz and powdered $SiO_2$/Pb pairs. (JRD)

**28381** MAGNETIC SHIFT OF THE QUADRUPOLAR NUCLEUS $^{63}Cu$ IN POLYCRYSTALLINE $Cu_2O$. Creel, R. B.; Griffin, C. F.; Worth, J. (Physics Department, The University of Akron, Akron, Ohio 44325, USA). Chem. Phys. Lett.; 33: No. 3, 560-562(15 Jun 1975).

Magnetic shift components can be measured for spin $^3/_2$ nuclei experiencing a strong symmetric nuclear electric quadrupole interaction by observation of the features of the NMR powder pattern in the quadrupole regime ($\nu_Q > \nu_\phi$). The perpendicular shift component has been previously measured in several materials by detection of the singularity at the low field edge of the pattern. The first measurement of the parallel shift component, obtained by observation of the high field edge, is reported here. For $^{63}Cu$ in $Cu_2O$, $\sigma = 0.0021 \pm 0.0002$. (auth)

**28382** NEW POROUS PYROCHLORES RICH IN POTASSIUM K/sub 1 + alpha/(Ta/sub 1 + alpha/W/sub 1 – alpha)$O_6$·$H_2O$? SYNTHESIZED BY CATION EXCHANGE IN THE SOLID PHASE. Michel, C.; Robert, C.; Groult, D.; Raveau, B. (Univ. de Caen, France). Mater. Res. Bull.; 10: No. 9, 949-955(Sep 1975). (In French).

Cationic exchanges properties in solid state of the pyrochlores Tl/sub 1 + alpha/(Ta/sub 1 + alpha/W/sub 1 - alpha/)$O_6$ with ions monovalents salts as KCl permit the synthesis of new pyrochlores K/1 + alpha/(Ta/1 + alpha/W/1 - alpha/)$O_6$.$H_2O$. The positions of potassium and water molecules in the lattice are discussed. Moreover, the study of the thermal stability of these compounds shows the formation of waterless pyrochlores K/sub 1 + alpha/(Ta/sub 1 + alpha/W/sub 1 - alpha)$O_6$. (auth)

**28383** PREPARATION AND STRUCTURE OF Eu/sup II/$Nb_4O_{11}$. Sato, K.; Maeda, K.; Adachi, G.; Shiokawa, J. (Osaka Univ., Suita, Japan). Mater. Res. Bull.; 10: No. 9, 989-992(Sep 1975).

The occurrence of compound in the system was studied by means of x-ray powder diffraction. A compound, $EuNb_4O_{11}$, was found. The x-ray powder diffraction data for $EuNb_4O_{11}$ could be indexed on a tetragonal cell with a equals 52.52 A, C equals 7.69 A. The temperature dependence of the magnetic susceptibility for this compound is expressed by the equation, chi/sub M/ equals 7.10/(T + 0.20). This compound is oxidized at about 290°C or above in air. (4 tables) (auth)

**28384** PREPARATION AND SUPERCONDUCTING PROPERTIES OF NIOBIUM CARBONITRIDE WIRES. Bernhardt, K. H. (Giessen Univ. (F. R. Germany). Inst. fuer Angewandte Physik). Z. Naturforsch., a; 30: No. 4, 528-532(Apr 1975).

Superconducting niobium carbonitride wires $Nb(C_yN_x)$ were prepared by a diffusion process in two steps, first diffusing carbon from methane into niobium wires and then nitrogen into these carbonized samples. The optimum conditions for these preparations were investigated in detail. All samples were analyzed quantitatively for C, N, and Nb. The carbonizing as well as the following nitriding of the wires was investigated under various conditions. The maximum of the transition temperature of the $Nb(C_yN_x)$ wires prepared by this two steps diffusion

process is reached for the same composition y, x as for sintered samples. But the value is about 0.4 K lower. (auth)

**28385** COMPACTION KINETICS OF HIGHER MOLYBDENUM AND TUNGSTEN BORIDES DURING HOT PRESSING. Kovalchenko, M. S.; Bodrova, L. G.; Fen, E. K. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 48-53(Jun 1975). (In Russian).

The compaction process is studied for higher molybdenum and tungsten borides during hot pressing. The values of the efficient Laplacian pressure are determined and the values of the activation energy are estimated for the investigated borides. It is shown that to obtain compact articles of powders of higher molybdenum and tungsten borides high pressures and temperatures close to the melting points of the given materials should be applied. (auth)

**28386** EFFECT OF METAL MELTS ON PYROGRAPHITE CRUCIBLES. Gurin, V. N.; Dergunova, V. S.; Popov, V. E.; Lyukshin, E. N. Refractories (USSR) (Engl. Transl.); 15: No. 9-10, 635-636(1974).

Translated from Ogneupory; 15: No. 10, 34-35(Oct 1974).

Trials were carried out on pyrographite crucibles for crystallizing the carbides of Groups IV-VI (Ta, W, Ti, Hf) from solutions in Al, Fe, Ni, and Ti melts. Results suggest that these crucibles are suitable for once-only use over a wide range of temperature and heating times. (DLC)

**28387** SUPERCONDUCTIVITY OF SOME BINARY AND TERNARY TRANSITION-METAL BORIDES. Vandenberg, J. M.; Matthias, B. T.; Corenzwit, E.; Barz, H. (Bell Labs., Murray Hill, NJ). Mater. Res. Bull.; 10: No. 9, 889-894(Sep 1975).

Superconducting transition temperatures of some binary transition-metal borides and a new series of ternary transition-metal borides are reported. The variation of T/sub c/ vs electron/atom ratio and the crystal chemical behavior of the borides in relation to their superconducting behavior are discussed. (auth)

**28388** PHASE RELATIONS IN THE V/sub x/Mo/sub 1-x/$O_2$ SYSTEM (0 LESS THAN OR EQUAL TO x LESS THAN OR EQUAL TO 0.55). Marinder, B. O. (Univ. of Stockholm). Mater. Res. Bull.; 10: No. 9, 909-914(Sep 1975).

The pseudo-binary system V/sub x/Mo/sub 1-x/$O_2$ (0 less than or equal to x less than or equal to 0.55) was studied by x-ray examination of samples quenched after prolonged heat treatment at temperatures between 400 and 1190°C. The phase diagram is complicated, with several rutile-related phases. Approach to equilibrium is sluggish in some areas. (auth)

**28389** ELECTRICAL CONDUCTIVITY OF SOLID SOLUTIONS IN THE SYSTEM $CeO_2$–$La_6WO_{12}$. Yoshimura, M. (Tokyo Inst. of Technology); Baumard, J. F. Mater. Res. Bull.; 10: No. 9, 983-988(Sep 1975).

The total electrical conductivities were studied for the solid solutions in the pseudo-binary system $CeO_2$–$La_6WO_{12}$. Maximum conductivities were observed at about 90 mole percent $CeO_2$, 1.1 $ohm^{-1}$ $cm^{-1}$ at 1500°C, and $4.4 \times 10^{-3}$ $ohm^{-1}$ at 600°C. A minimum point was observed in conductivity isotherms at about 10 mole percent $CeO_2$. A pyrochlore-like stoichiometric compound $La_2$ (LaCe/sub 1/2/ W/sub 1/2/)$O_7$ was assumed. The crystal structure of $La_6WO_{12}$ is discussed. Ionic conductions were observed at low temperatures. (auth)

**28390** X-RAY SCATTERING AND THE $\alpha-\alpha'$ PHASE TRANSITION IN COHERENT METAL–HYDROGEN SYSTEMS. Burkhardt, T. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung); Woeger, W. (Koeln Univ. (F. R. Germany). Inst. fuer Theoretische Physik; Kernforschungsanlage Juelich G. m. b. H. (F. R. Germany). Inst. fuer Festkoerperforschung). Z. Phys., B; 21: No. 1, 89-94 (May 1975).

In an $\alpha-\alpha'$ phase transition of the type discussed by Wagner and Horner, the elastic interaction of the hydrogen interstitials via the strain field of the coherent host lattice is assumed to provide the attraction responsible for the phase transition. One can test this assumption by mapping the lattice distortions near the surface of a sample undergoing the transition by using a narrow beam of x rays and measuring shifts in the Bragg maxima. What is to be expected theoretically in an experiment of this type using a coherent, spherical Nb sample is discussed. In addition to the case of thermodynamic equilibrium the time dependence of the shifts in the Bragg maxima as equilibrium is approached after quenching the sample to a different temperature is considered. (auth)

**28391** SPECTROSCOPIC INVESTIGATIONS IN SOLID-STATE CHEMISTRY. IX. Re-NQR-Investigations on $RbReO_4$. Burkert, P. K.; Hutter, F.; Koth, D. (Technische Univ. Muenchen (F. R. Germany). Anorganisch-Chemisches Lab.). Z. Naturforsch., b; 30: No. 2, 198-201(May 1957). (In German).

The four $^{185}Re$, $^{187}Re$-NQR-transitions of $RbReO_4$ were measured. From the NQR-coupling constants, asymmetry-parameter, and normal temperature-coefficient in the range of 77 to 300°K it can be concluded that the anomalous temperature dependence of the NQR-frequencies of $NH_4ReO_4$ is not caused by the absolute values of certain lattice parameters. An experimental correlation of the Re-NQR-coupling constants of scheelite-structured perrhenates with the length of the elementary cell was found and discussed. (GE)

**28392** TERNARY TELLURIDES $MgAl_2Te_4$, $MgGa_2Te_4$, AND $MgIn_2Te_4$. Dotzel, P.; Franke, E.; Schaefer, H.; Schoen, G. (Technische Univ. Darmstadt (F. R. Germany). Fachbereich Anorganische Chemie und Kernchemie). Z. Naturforsch., b; 30: No. 2, 179-182(Mar 1975). (In German).

$MgAl_2Te_4$, $MgGa_2Te_4$, and $MgIn_2Te_4$ were prepared by direct synthesis from the elements at 1,000°C. $MgIn_2Te_4$ crystallizes tetragonal in a variation of the zincblende structure. The vacancies are ordered as in $\beta$-$Cu_2HgJ_4$, the Mg- and In-atoms are distributed randomly in the cation sites of this structure. (GE)

**28393** CRYSTAL STRUCTURE OF $MnIn_2Te_4$, A NEW TYPE OF ORDERED DEFECT ZINCBLENDE PHASES. Range, K. J.; Huebner, H. J. (Muenchen Univ. (F. R. Germany). Inst. fuer Anorganiscne Chemie). Z. Naturforsch., b; 30: No. 2, 145-148(Mar 1975). (In German).

1 fig.; 3 tabs.; 4 refs.

$MnIn_2Te_4$ was prepared by direct synthesis from the elements at 800°C. The crystals are tetragonal, space group I42 m, with a = 6,191 A, c = 12,382 A, and Z = 2. The structure can be derived from the zincblende structure. It is related to the $CdGa_2S_4$ and $\beta$-$Cu_2HgJ_4$ type structures with the same ordered arrangement of vacancies. In $MnIn_2Te_4$, however, the different cations are distributed randomly over the occupied tetrahedral sites. (GE)

**28394** EFFECTIVE MAGNETIC MOMENTS OF THE EUROPIUM-MONOCHALCOGENIDES. Koebler, U.; Fischer, K. J. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung). Z. Phys., B; 20: No. 4, 391-397 (Apr 1975).

4 figs.; 1 tab.; 29 refs.

The paramagnetic susceptibility and the saturation magnetic moment of a number of polycrystalline samples of all four europium monochalcogenides were measured. Many of them exhibit a negative susceptibility at 2°K and magnetic fields of 70 kOe, rather than the expected saturation behavior. The ratio between the Curie-Weiss constant C and the saturation moment $M_0$ was evaluated in order to eliminate the unreliably known number N of the $Eu^{2+}$ ions. The quantity $R = g_{(J)}\sqrt{J(J+1)}$ extracted in this way should have the value $R_0 = 9.00$ for $g = 2$ and $J = S = 7/2$. The measured values, 9.72, 9.33, 9.32, and 9.50 for EuO, EuS, EuSe, and EuTe, respectively, can be correlated directly with the magnetic hyperfine fields, which are −305, −330, −328, and −315 kOe in the ferromagnetic aligned states. Both results together lead to the assumption that the magnetic moment per Eu-ion is enhanced over the $^8S_{7/2}$-value by spin contributions of outer 5d or 6s electrons. (GE)

**28395** MAGNETOOPTICS AND ELECTRONIC STRUCTURE OF THE MAGNETIC ORDERING EUROPIUM CHALCOGENIDES. Schoenes, J. (Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. fuer Festkoerperphysik). Z. Phys., B; 20: No. 4, 345-368(Apr 1975). (In German).

29 figs.; 3 tabs.; 115 refs.

The absorption coefficient and the interband Faraday rotation of EuS, EuSe, and EuTe thin films have been measured as function of the photon energy (1 to 6 eV), at 2.7 to 300°K and an applied magnetic field of 0 to 11.5 kOe. In addition a magnetic field modulation technique has been developed, with a resolution of $2 \times 10^{-4}$ deg. This allows the measurement of the Faraday rotation in fields of only 100 Oe, which is important for metamagnetic samples with low critical fields. (GE)

**28396** INTERACTION IN THE SYSTEM ZrC–$ZrB_2$. Ordaniyan, S. S.; Unrod, V. I. (Leningrad Technological Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 61-64(May 1975). (In Russian).

In the system ZrC–$ZrB_2$ mutual solubility of the components is practically absent below 2100°C, only at a temperature of 2650°C there occurs a slight dissolution of $ZrB_2$ (< 2% by mass). The state diagram of the system ZrC–$ZrB_2$ plotted on the basis of data of x-ray diffraction and metallographic analyses, measurements of temperatures of the alloys melting start, and microhardness of their structural components is of eutectic character

with $T_{eut}$ = 2660 ± 40° and eutectics composition – 57% $ZrB_2$ and 43% ZrC. (auth)

**28397** HIGH-TEMPERATURE INTERACTION OF TITANIUM WITH MATERIALS BASED ON $ZrO_2$. Gropyanov, V. M.; Fedorova, G. M.; Yudin, B. F. (Leningrad Technological Inst.). Inorg. Mater.; 11: No. 1, 85-87(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 105-107(Jan 1975).

A thermodynamic analysis of the reaction between $ZrO_2$ and titanium shows that above 2000°K, formation of TiO, ZrO, and Zr in the gas phase is thermodynamically probable. The results of the thermodynamic analysis were experimentally verified by melting Ti in $ZrO_2$ crucibles. (auth)

**28398** HOT GAS STRESS CORROSION OF SILICON NITRIDE AND SILICON CARBIDE. Rowcliffe, D. J. (Brown, Bover and Co. Ltd., Baden, Switz.); Huber, P. A. Proc. Br. Ceram. Soc.; No. 25, 239-252(May 1975).

From joint meeting of the Basic Science Section of the British Ceramic Society and the Materials and Testing Group of the Institute of Physics on mechanical properties of ceramics; London, Eng. (17 Dec 1974).

Time to failure data were obtained on samples of hot-pressed silicon nitride and hot-pressed silicon carbide loaded statically to known initial stress intensities in combustion gases at 1173 and 1223°K. Additions of sodium, magnesium, and vanadium to the fuel do not noticeably affect the failure times. However, for a given initial stress intensity, failure is more rapid in both materials than in similar tests in still air. For silicon nitride, failure times are shorter at 1223 than at 1173°K but there is no difference for silicon carbide. Localized corrosion at the roots of notches is responsible for the decreased lives in the hot gas tests. In both materials, tested at room temperature following exposure to the hot gas, fracture toughness can be higher than under normal conditions. This appears to be associated with the sealing of cracks by the corrosion products. (auth)

**28399** SINTERING OF OPEN AND CLOSED POROSITY IN $UO_2$. Coleman, S. C.; Beere, W. B. (Central Electricity Generating Board, Berkeley, Eng.). Philos. Mag.; 31: No. 6, 1403-1413(Jun 1975).

High green density $UO_2$ powder compacts were annealed over a range of temperatures to establish the sintering mechanisms for open and closed porosity. During the intermediate stage of sintering the interconnected porosity was found to sinter at a rate consistent with a volume diffusion process dependent on the instantaneous grain size. The apparent activation energy for open pore sintering was significantly higher than that for volume or grain boundary diffusion, this being attributed to systematic differences resulting from the grain growth process. The fraction of closed porosity increased to a maximum with the collapse of the open porosity then decreased during the final stage of sintering. (auth)

**28400** IMPROVEMENTS IN OR RELATING TO THE DRYING OF WET GEL ENTITIES. Ellis, J. F. (to United Kingdom Atomic Energy Authority). British Patent 1,391,416/B/. 23 Apr 1975. 2p.

Reference is made to methods for the production of kernels for coated fuel particles. One method is that of gel precipitation, and subsequent drying, calcining, and sintering to give a dense ceramic material. A method for the drying of the products of the gel precipitation process is described, in which the wet gel materials are dispersed in trichlorethylene or perchlorethylene, or a mixture of the two, and heated to drive off the water. The gel products are then separated from the chlorhydrocarbon. Apparatus for carrying out the process is described, with reference to spheres of ammonium diuranate obtained by the gel precipitation process. Advantages of the use of trichlorethylene or perchlorethylene are their low toxicity, relatively high boiling point, reducing fire risks, and avoidance of agglomeration of spheres during drying. (UK)

**28401** IMPROVEMENTS IN OR RELATING TO CERAMIC NUCLEAR FUEL. Steele, B. R. (to United Kingdom Atomic Energy Authority). British Patent 1,393,101/B/. 7 May 1975. 3p.

Requirements sometimes arise for low-density sintered $UO_2$ nuclear fuel pellets, typically of density in the range 9.9 to 10.4 g/cc, as compared with the more usual densities of 10.6 to 10.75. These can be produced by increasing the crystal size of the $UO_2$ powder by calcining at a higher than usual temperature. Alternatively they can be produced from standard $UO_2$ powder by addition of a filler that decomposes during sintering or special treatment. In the method described, dextrin is incorporated as filler material and the pellets are subsequently sintered. The dextrin burns out on sintering and leaves pores, so that the product is of relatively low density. Details are given of methods of carrying out the process. (UK)

**28402** MANUFACTURE OF NUCLEAR FUEL PARTICLES. Billson, N. L.; Lefevre, R. L. R. (to United Kingdom Atomic Energy Authority). British Patent 1,392,602/B/. 30 Apr 1975. 3p.

Formation of spheroidal nuclear fuel kernels by the "slow growth" method involves two basic steps, firstly agglomeration of powder grains and a binder (stearic acid) to form spheroidal "green" kernels, and secondly heat treatment of the "green" kernels at a low temperature to remove the binder, and subsequently at a higher temperature to sinter them and render them suitable for coating. The method described represents an improved "green" kernel production process, employing the "slow growing" process. A mixture of nuclear fuel and binder, in powder form, is applied on rolling "seeds" so that spheroidal "green" kernels commence to grow by agglomeration. The growth is interrupted from time to time and counted samples are weighed to determine the average weight of the kernels, the growth then being continued while applying sufficient of the mixture to raise the average weight of the "green" kernels to that desired. Finally the "green" kernels are heat treated at up to 350°C to remove binder and then to at least 1350°C to sinter and produce pores in the kernels. The process may be applied to "green" $U_3O_8$ kernels, which may be directly sintered and reduced to $UO_2$ kernels of the required porosity, without pre-sintering, and can be made sufficiently dense without requiring further heat treatment. In this case the final heat treatment is effected first in vacuum and then in a reducing atmosphere ($H_2$/Ar); this fixes the grain boundaries and reduces the $U_3O_8$ to $UO_2$. (UK)

**28403** SINTERING OF BeO UNDER HYDROSTATIC PRESSURE OF 20 KBARS. Kodaira, K. (Hokkaido Univ., Sapporo, Japan); Matsushita, T.; Koizumi, M. Mem. Fac. Eng., Hokkaido Univ.; 14: No. 1, 107-111(Mar 1975).

An attempt to examine the effect of hydrostaticity of pressure at 20 kbars on sintering of BeO was made using a glass cell. The activation energy for grain growth was found to be about 71 kcal/mole. The values of activation energy and rate constant of grain growth are in good agreement with those for hot isostatic pressing at 2 kbars. The effect of applied pressures on grain growth was not dependent on the magnitude of pressure in a range of 2 to 20 kbars. (auth)

**28404** INFLUENCE OF PREPARATION CONDITIONS ON THE MECHANICAL PROPERTIES OF Ni AND Ni ALLOY BONDED Ta–Hf CARBONITRIDES. Komac, M. (Univ., Ljubljana, Yugoslavia); Kolar, D.; Kosmac, T.; Thuemmler, F. Proc. Br. Ceram. Soc.; No. 25, 187-196(May 1975).

From joint meeting of the Basic Science Section of the British Ceramic Society and the Materials and Testing Group of the Institute of Physics on mechanical properties of ceramics; London, Eng. (17 Dec 1974).

Cemented carbides, based on Ta–Hf carbonitrides, are of potential interest for the manufacture of cutting tools and wear resistant construction details. The nonstoichiometry of the carbonitride phase promotes the chemical reaction with the binder phase during sintering, thus resulting in formation of intermetallic and complex carbide phases. This in turn influences the wetting behaviour, densification, and microstructure of specimens. The above phenomena were studied in the systems of Ta–Hf-carbonitrides with nickel and nickel-base alloys and correlated with mechanical properties, such as hardness, bending strength, and wear resistance. Conclusions are drawn on the applicability of the investigated materials. (auth)

**28405** THERMAL FRACTURE IN CERAMIC MATERIALS. Evans, A. G. (National Bureau of Standards, Boulder, CO). Proc. Br. Ceram. Soc.; No. 25, 217-237(May 1975).

From joint meeting of the Basic Science Section of the British Ceramic Society and the Materials and Testing Group of the Institute of Physics on mechanical properties of ceramics; London, Eng. (17 Dec 1974).

Novel techniques are used to evaluate both the conditions for the onset of rapid fracture and the extent of the strength degradation under thermal shock conditions. The fracture onset is studied using an acoustic emission technique, which shows that a simple equation of the peak thermal stress and the critical crack propagation stress adequately describes fracture, for relatively small flaws, provided that slow crack growth effects are incorporated. The strength degradation is examined by studying crack arrest conditions. These studies show that crack arrest can be characterized by a critical stress intensity factor condition, modified by inertia/stress wave effects, when these are important. Some

implications of these results are discussed with special reference to silicon nitride and silicon carbide. (auth)

**28406** IDENTIFICATION OF A SERIES OF CUBIC NITRIDE-CARBIDES OF PRASEODYMIUM FORMED BY REACTIVE ARC MELTING. Colquhoun, I.; McColm, I. J. (Univ. of Bradford, Eng.). J. Inorg. Nucl. Chem.; 37: No. 7/8, 1705-1708(Jul 1975).

Two series of fcc nitride-carbide phases of praseodymium were identified in the products of the reactions between $PrC_2$ + PrN, PrN + C, and Pr + HCN. The highest yields were found in the case of reactive arc melting of the metal with hydrogen cyanide. From a combination of x-ray, metallographic, and hydrolysis techniques the composition ranges of these nitride-carbides were determined. One series is found in the presence of small amounts of Pr metal and has a total nonmetal content x + y in $PrN_xC_y$ close to unity while the second series is found with $Pr_2C_3$ and has x + y < 0.9. Both series contain only methanide $C_1$ carbon units even when y > 0.8. The presence of nitrogen is shown to be essential to the formation of methanide carbides in this system. The results from these experiments are compared to those from the Ce-N-C system where greater difficulty is encountered in stabilising methanide phases. (auth)

**28407** INFLUENCE OF MICROSTRUCTURE OF $Al_2O_3$ AND $ZrO_2$ ON $K_{IC}$. Claussen, N.; Pabst, R.; Lahmann, C. P. (Max-Planck-Institut fuer Hirnforschung, Frankfurt am Main). Proc. Br. Ceram. Soc.; No. 25, 139-149(May 1975).

From joint meeting of the Basic Science Section of the British Ceramic Society and the Materials and Testing Group of the Institute of Physics on mechanical properties of ceramics; London, Eng. (17 Dec 1974).

Correlations between the microstructure of ceramic materials and their crack behaviour are insufficiently known. The determination of $K_{IC}$-factors using the notch beam test can be applied for sensitive detection of even small structural changes. Results for various sintered and hot-pressed alumina samples show a decrease of $K_{IC}$ with increasing grain size, as long as the fracture is intercrystalline. If the fracture mode changes, $K_{IC}$ increases with an increasing fraction of transcrystalline fracture which is usually coupled with increasing grain size. Partially stabilised sintered zirconia fractured in a completely transcrystalline manner, with $K_{IC}$ considerably higher than for the stabilised $ZrO_2$. The high temperature dependence of $K_{IC}$ shows a typical decrease in the case of pure alumina at higher temperatures. However, alumina plus 3% $SiO_2$ shows a significant increase of 60% at 910°C before the typical drop due to the glassy phase at the grain boundaries. The thermal shock behaviour is studied by determination of the critical quenching temperature and the strength loss. Good agreement was found between the thermal shock resistance in terms of $K_{IC}$ and the strength loss. (auth)

**28408** VARIATION OF YOUNG'S MODULI WITH TEMPERATURE OF $\alpha$ SiC. Veldkamp, J. D. B. (Philips Gloeilampenfabrieken N. V.: Eindhoven, Netherlands); Uijterschout, M. I. L. Proc. Br. Ceram. Soc.; No. 25, 211-216(May 1975).

From joint meeting of the Basic Science Section of the British Ceramic Society and the Materials and Testing Group of the Institute of Physics on mechanical properties of ceramics; London, Eng. (17 Dec 1974).

Recently an increase with temperature of Young's moduli of $\alpha$ SiC was reported in the range from 700 to 1400°C with respect to the room temperature value. This increase could partly account for the known increasing strength of pure $\alpha$ SiC with temperature. The behavior was tentatively correlated with the thermal expansion and specified heat properties, which led to the expectation that the moduli should first decrease from room temperature to about 200°C and then increase. New measurements on both $\alpha$ and $\beta$ SiC were performed from room temperature to about 900°C. The modulus in [10.0] of $\alpha$ SiC decreases as expected with temperature to a minimum of 98% of the room temperature value at about 200°C. Above this temperature the modulus increases. The modulus in [00.1] decreases with temperature to a minimum at about 350°C, being 95% of the room temperature value. This modulus also increases above this temperature but much less than the modulus in [10.0]. The variation of the moduli thus corresponds qualitatively with the expected behaviour. The modulus in [110] of $\beta$ SiC, however, shows a normal temperature behaviour. The temperature dependence of the moduli of $\alpha$ SiC is explained by the presence of imperfectly bonded parallel lamellae in $\alpha$ SiC. (auth)

**28409** ANTIFERROMAGNETIC ORDERING IN TERBIUM DIHYDRIDE. Bieganski, Z.; Opyrchal, J.; Drulis, M. (Instytut Niskich Temperatur i Badan Strukturalnych, Wroclaw). Solid State Commun.; 17: No. 3, 353-354(1 Aug 1975).

The specific heat of terbium dihydride, $TbH_{2.01}$, was measured in the temperature range from 4 to 200°K. An extremely sharp $\lambda$-type specific heat anomaly due to an antiferromagnetic transition was found at $T_N = 16.06 \pm 0.01$°K. (auth)

**28410** CALCULATION OF THE SUPERCONDUCTING TRANSITION TEMPERATURE $T_c$ FOR METALS WITH PHONON-ANOMALIES. Haufe, U.; Kerker, G.; Bennemann, K. H. (Freie Univ., Berlin). Solid State Commun.; 17: No. 3, 321-325(1 Aug 1975).

It is shown that the electron-phonon coupling constant and $T_c$ of the refractory transition metals VC, VN, NbC, etc. can be obtained from $\lambda$ and $T_c$ of the corresponding transition metals V, Nb, etc. Results suggest that superconductivity in the refractory metals involves mainly d-electron transitions between the transition-metal atoms. (auth)

**28411** ESR INVESTIGATION OF THE PRODUCTS OF ROASTING COPRECIPITATED ZIRCONIUM AND MANGANESE HYDROXIDES. Orlik, Yu. G.; Vasilenko, A. I.; Lesnikovich, A. I. (Belorussian State Univ., Minsk). Inorg. Mater.; 11: No. 1, 156-157(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 183-184(Jan 1975).

The MnO content was set at 0.05, 0.5, or 5 mole %. Shape changes in the hfs lines due to roasting and HF treatment were observed. Resonance absorption is supposed to be due to Mn ions forming a solid solution in cubic or tetragonal $ZrO_2$, with the axial distortion being caused by oxygen vacancies linked to a Mn ion. The constant hfs intensity can be explained by the formation of monoclinic $ZrO_2$ at low temperatures. The Mn impurity is localized on the surface of the particles. (DLC)

**28412** ELECTRICAL RESISTIVITIES AND THERMO-EMF's OF IRON AND COBALT MONOBORIDES. Budozhapov, V. D.; Sidorenko, F. A.; Zelenin, L. P.; Gel'd, P. V.; Chemerinskaya, L. S. (Ural Polytechnic Inst., USSR). Inorg. Mater.; 11: No. 1, 146-147(Jan 1975).

Translated from Izv. Akad. Nauk SSR, Neorg. Mater.; 11: No. 1, 173-174(Jan 1975).

The temperature dependences of the electric resistivity (78 to 1280°K) and thermo-emf (78 to 300°K) were determined. For FeB between 78 and 400°K, the resistivity follows the equation $\rho = (-0.20 + 5.2 \times 10^{-3}\ T) \times 10^{-8}$; above the Curie point (598°K), $\rho$ does not vary with temperature. $\rho$ of CoB is large and has semiconductor character: $\rho = A \exp(\Delta E/2kT)$, with $\Delta E = 0.011$ eV between 80 and 180°K and 0.20 eV between 600 and 1200°K. The absolute thermo-emf coefficients were found to be different for FeB and CoB. The difference between FeB and CoB is due to their conductivity bands; that of CoB is completely filled, while the Fermi level lies above this band in a region with zero or very small density of states. (DLC)

**28413** CROSS SECTION OF THE SYSTEM $Eu_2O_3$-$La_2O_3$-$Ta_2O_5$ WITH $Ta_2O_5$ CONTENT OF 50 MOLE %. Ustimovich, A. B.; Pinaeva, M. M.; Kuznetsova, V. V. (Inst. of Physics, Minsk). Inorg. Mater.; 11: No. 1, 66-68(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 82-85(Jan 1975).

In the system $Eu_2O_3$-$La_2O_3$-$Ta_2O_5$ at a $Ta_2O_5$ content of 50 mole % and a temperature of 1250°C, x-ray, electron-microscopic, and luminescence analyses revealed the existence of two types of solid solution. One is based on the monoclinic structure of $LaTaO_4$ in the range ~ 0 to 15 mole % $Eu_2O_3$ and the other is based on the monoclinic structure of the fergusonite type in the range ~ 60 to 100 mole % $Eu_2O_3$. With a $Eu_2O_3$ content in the range ~ 15-60 mole %, both solid solutions are present simultaneously. (auth)

**28414** PROPERTIES OF $Nb_2C$ AND $V_2C$ IN THE REGION OF HOMOGENEITY. Samsonov, G. V.; Timofeeva, I. I.; Naumenko, V. Ya.; Bazhenova, L. N.; Rud, B. M. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater.; 11: No. 1, 50-52(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 62-65(Jan 1975).

On the basis of chemical, x-ray phase, and metallographic analyses, the regions of homogeneity of $Nb_2C$ and $V_2C$ were determined more accurately; their limits are $NbC_{0.42}$-$NbC_{0.50}$ and $VC_{0.41}$-$VC_{0.49}$ respectively. In contrast with NbC, the concentration dependences of the electrical properties of $Nb_2C$ have a monotonic character. (auth)

**28415** PEROVSKITE PHASES IN THE SYSTEM $BaO$-$UO_{2+x}$ WITH x LESS THAN 1. Braun, R.; Kemmler-Sack, S.; Roller, H.; Seemann, I.; Wall, I. (Univ. Tuebinger, Ger.). Z. Anorg. Allg. Chem.; 415: No. 2, 133-155(Jul 1975). (In German).

The phase relations in the $BaO$-$UO_{2+x}$ system are investigated by x-ray and spectroscopic methods. The higher boundary of the perovskite phase is situated near Ba: U = 3:1. The phase range depends on the Ba:U ratio as well as on the uranium valency. The

composition $BaUO_3$ is not obtained. The stability of the phase is heavily influenced by the possibility of charge delocalisation. The properties of a new ternary oxide, 1.47 $BaO \cdot UO_{2.525}$, are reported as well. (auth)

**28416** METHOD AND EQUIPMENT FOR THE COATING OF HIGH-TEMPERATURE FUEL ELEMENT PARTICLES CONTAINING FUEL, FERTILE, OR ABSORBER MATERIAL. Huschka, H.; Warzawa, W. (to Hochtemperatur-Reaktor-Brennelement GmbH (HOBEG)). German(FRG) Patent 2,343,123/S/. 27 Mar 1975. 11p. (In German).

A procedure concerned with producing particles in a fluidized bed is described. The working gas is blown into the turbulent particle bed through one or more nozzles at a higher speed than the carrier gas and–from the top–against the flow of the carrier gas which causes turbulance. (GE)

**28417** METHOD OF PRODUCTION OF URANIUM CARBIDE SPHEROIDS. Ford, L. H.; Ingleby, B. E.; Hibbert, N. S. (to UKAEA London Office). German(FRG) Patent 1,471,511/B/. 16 Jan 1975. 4p. (In German).

Methods of preparing uranium carbide spheroids which are filled into molded bodies made of refractory material for fuel elements are described. Layers of pyrolytic material are incorporated to retain the fission products. A first thin layer of pyrolytic carbon is applied to the spheroid step by step at low temperature, followed by a second outer coating of fission products-retaining, refractory material. The uranium carbide spheroids are coated with the pyrolytic carbon at a temperature of over 1,500°C. (GE)

**28418** RECOVERY OF c-AXIS SPACING IN PYROLYTIC GRAPHITE AFTER NEUTRON IRRADIATION AT 5K. Maeta, H.; Iwata, T.; Okuda, S. (Japan Atomic Energy Research Institute, Tokai-mura, Ibarakiken, Japan). Phys. Lett., A; 53: No. 4, 295-296(30 Jun 1975).

Recovery of the c-axis spacing expansion in pyrolytic graphite after neutron irradiation at 5°K was measured in the range of 5 to 900°K by the x-ray diffraction method. An unexpectedly large recovery of the spacing was found around 100°K. (auth)

**28419** PRODUCTION OF LANTHANUM HEXABORIDE FILMS BY SYNTHESIS FROM ELEMENTS. Paderno, Yu. B.; Ivanchenko, L. A.; Bessaraba, V. L; Vereshchak, V. M. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 106-108(Jun 1975).

Thin films of lanthanum hexaboride are obtained for the first time using elementary lanthanum and boron in successive vacuum thermal spraying. Optical characteristics are obtained for the spectrum visible region from which certain parameters of electrotransport of the obtained films are calculated. (auth)

**28420** TESTING OF HARD ALLOY BK20 FOR STRENGTH UNDER OPERATING CONDITIONS OF CRANK PRESS. Smolyaninov, V. P.; Spirina, S. I. (Kharkov Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 102-105(Jun 1975). (In Russian).

A device is described by means of which fatigue tests of BK20 samples are carried out under operating conditions of the crank press. An accelerated step type method is applied to compare fatigue characteristics of two lots of samples. A change in the technological residual stresses in WC–Co alloys is established to influence the value of fatigue characteristics. (auth)

**28421** APPLICATION OF THERMODYNAMICS TO NUCLEAR FUELS. Rand, M. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 3-13 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/Pub-380(Vol. 1); CONF-741030-P1.

Thermodynamic analysis has helped to provide an understanding of one of the more complicated high-temperature systems found in industry today, an irradiated nuclear fuel. Recent developments in the use of thermodynamics to explain and predict the behavior of nuclear fuels under a range of conditions are discussed. Emphasis is placed on current problems. Five main topics are: (i) Mass transport of fissile, fertile, fission-product, and impurity atoms in steep temperature gradients encountered in many nuclear fuels. It is becoming increasingly important to take account of such chemical effects in the many models of the physical behavior of irradiated fuels which are being considered; (ii) Cladding effects—the presence of fission products and impurity atoms also has a marked effect on the reactions occurring at the fuel/clad interface; (iii) Failed fuel—rupture of the cladding or coating may lead to fuel/coolant reactions, understanding of which often benefits from a close thermodynamic analysis; (iv) Safety considerations—the need to understand more fully the behavior of the fuel in a hypothetical reactor accident has led to an interest in thermodynamic properties above 3000°K. In particular, the need to predict explosion yields requires some knowledge of the equation of state of an irradiated fuel. Recent work in this field is discussed, with emphasis on the need to develop more satisfactory models to extrapolate existing data; (v) Basic data—all thermodynamical analyses rest on the availability of accurate self-consistent data, and the unsatisfactory state of much of the data for many of the important fuel constituents (oxides, carbides and stainless steel) is noted. (auth)

**28422** MODELLING OF U, Pu, AND O REDISTRIBUTION IN OXIDE FUELS BY VAPOR TRANSPORT AND DIFFUSION. Blackburn, P. E.; Johnson, C. E. (Argonne National Lab., IL). pp 17-33 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1);(CONF-741030-P1.

A computer model has been written to determine redistribution of uranium, plutonium, and oxygen in irradiated fuels both as a function of time and at steady-state conditions. Oxygen movement is controlled by ionic diffusion, where the driving force is the product of an activity-independent coefficient and the oxygen activity (represented by the atomic oxygen pressure). Coefficients were derived from data for lattice diffusion of ions through vacancies and interstitial ion diffusion. For diffusion through vacancies, a distinction is made between low O/M fuel (near the metal-rich boundary) in which lattice diffusion depends on oxygen activity and fuel near stoichiometric composition, in which diffusion is limited by low vacancy concentrations. Steady-state oxygen distribution is achieved when, over the O/M range of interest, no gradient exists in the product of the appropriate diffusion coefficient and the atomic oxygen pressure. Solid-state oxygen-ion diffusion is much more rapid in the fuel than gas-phase oxygen transport. Redistribution of uranium and plutonium occurs by vapor-phase transport through the porous fuel. As the gaseous actinide species diffuse from the hot side to the cool side of the pores, non-congruent vaporization and condensation within the pores result in changes in the uranium and plutonium distribution. When the central portion of the fuel, which is hot enough to vaporize actinides, densifies (with concurrent enlargement of the central void), migration of the gaseous actinide species virtually ceases. The redistribution model is found to predict distributions of all three elements in reasonable agreement with observations of irradiated fuels. (auth)

**28423** EFFECT OF STRUCTURAL-THERMODYNAMIC FEATURES ON THE MECHANISMS GOVERNING DIFFUSION IN HIGH-MELTING MATERIALS. Andrievskii, R. A.; Borisov, E. V.; Maksimov, V. P.; Senchukov, A. D.; Shlykov, V. I.; Yanchur, V. P. (Inst. of Atomic Energy, Moscow). pp 35-43 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Aspects of the diffusion of interstitial and substitutional elements in high-melting metals and alloys are considered. The interaction of carbon and nitrogen with zirconium alloys is frequently accompanied by diffusional redistribution of the metal components. The data are analyzed on the basis of the concepts of diffusion in three-component systems. Results are also reported illustrating the part played by boundary diffusion during interaction in the systems W–Mo and $UO_2$–Mo(W), and draw attention to the co-operative nature of diffusion in the latter case. (auth)

**28424** STEADY AND TRANSIENT THERMODYNAMIC TEMPERATURE IN COMPOSITE NUCLEAR FUEL RODS. Krudener, R. M.; Wolf, H. (Univ. of Arkansas, Fayetteville). pp 45-58 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

A finite difference method is described for calculating steady and transient thermodynamic temperature histories for a multi-region fuel rod comprised of an 80 : 20 mixture of $UO_2$ and $PuO_2$ and having a high-conductivity auxiliary path to conduct energy out to the coolant. Results were calculated for two sizes of center void, 0.080 in. and 0.125 in. at a Reference Design power level of 18 kW/ft and a fuel pellet of nominal 0.244 in. cold diameter and 0.125 in. long. The pellets are separated by solid molybdenum washers 0.025 in. thick and enclosed by stainless steel cladding. The solution to the elliptic and parabolic boundary value problems were obtained by adaptations of the Peaceman–Rachford method and the application of new methods for obtaining sets of Wachspress

acceleration parameters that have dramatically increased the rates of convergence. Details of the numerical procedure are not given but are briefly described. Steady-state temperature distributions were computed for the range of 18 to 27 kW/ft at pertinent values of the interface conductances. Transient temperature histories were calculated for exponential power excursions from the above steady-state conditions to determine critical maximum temperatures for two-second doubling times. Tabular values of maximum and other pertinent fuel temperatures for representative values of the interface conductances are presented along with representative temperature histories for steady-state and transient conditions in graphical form. (auth)

**28425** OXYGEN REDISTRIBUTION AND ITS MEASUREMENT IN IRRADIATED OXIDE FUELS. Adamson, M. G. (General Electric Co., Pleasanton, CA); Aitken, E. A.; Evans, S. K.; Davies, J. H. pp 59-72 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

The results of several new series of ex-reactor thermal gradient experiments performed on hypostoichiometric mixed oxide and hyperstoichiometric urania, with and without added cesium, are presented and discussed in terms of an oxygen transport model applicable to irradiated LMFBR fuel pins. Mixed oxide tests were carried out with variable numbers of pellet interfaces in a fixed temperature gradient, and also with molybdenum barriers placed between pellets, to examine the effects periodic formation and disappearance of cracks and pores in neutron irradiated fuel will have on the oxygen transport mechanism. Differences in the heats of transport measured in these tests are attributed to local oxygen potential gradients which quickly develop across fuel-gas-fuel interfaces during the approach to steady state. Thermomigration studies on cesium oxide fuel systems have demonstrated that cesium fission products will participate in the over-all oxygen redistribution process in irradiated oxide fuels. The effectiveness of cesium as an oxygen carrier in a temperature gradient is shown to depend on the over-all oxygen activity of the fuel and the hydrogen content of the gas phase. An emf oxygen probe, based on a solid oxide electrolyte high temperature galvanic cell, has been developed to measure oxygen potentials and oxygen gradients in irradiated oxide fuels. The feasibility of making such measurements was demonstrated by probing four transverse fuel sections cut from a series of low and high burn-up irradiated Zircaloy-clad urania fuel rods. The results are interpreted in terms of current chemical models for irradiated oxide fuel. (auth)

**28426** RADIAL TRANSPORT OF OXYGEN IN MIXED-OXIDE FUEL PINS. Sari, C. (European Inst. of Transuranium Elements, Karlsruhe, Ger.); Schumacher, G. pp 73-82 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Two transport mechanisms are responsible for the radial transport of oxygen occurring due to the temperature gradient in mixed oxide fuel pins, (i) diffusion of oxygen in the pressure gradient of carrier gases in cracks and pores and (ii) thermal diffusion of oxygen ions in the solid matrix. Solid-state thermal diffusion is the dominant process in dense parts of the fuel, such as the columnar grains. Experiments were conducted to examine thermal diffusion in dense $(U_{0.85}Pu_{0.15})O_{2-x}$ pellets. They reveal that the gradient in oxygen concentration diminishes with decreasing O/M ratios and vanishes at a plutonium valence of 3.3. Calculations of oxygen distribution in the columnar grain region were carried out using the effective heat of transport, which was estimated as a function of plutonium valence. The additional use of Aitken's cyclic-flow model for the outer fuel region allows a prediction of the whole O/M profile. (auth)

**28427** MIGRATION AND VAPOR PRESSURES OF FISSION PRODUCTS IN AN IRRADIATED MIXED OXIDE. Dean, G.; Mouchnino, M.; Sauvage, R.; Schmitz, F. (CEN, Fontenay-aux-Roses, France). pp 83-98 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975). (In French).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Vapor pressure measurements performed by the Knudsen effusion method on an oxide fuel less than a month after its removal from the Rapsodie reactor showed the presence of numerous stable compounds of fission products. The low partial pressures observed in the case of cesium and iodine could be explained by the presence of oxygenated compounds of molybdenum in the oxide. The oxygen potentials deduced from the results are compatible with a mixed oxide $(U,Pu)O_2$ which is near-stoichiometric for the periphery and sub-stoichiometric at the center. The pressures observed in the case of barium and zirconium can be explained by the presence of barium zirconate and uranate in the solid. The results obtained on a metallic globule prove that it is formed along the entire irradiation length by an evaporation-condensation phenomenon. (auth)

**28428** MIGRATION OF Cs AND Mo IN IRRADIATED OXIDE FUELS. Johnson, I.; Johnson, C. E. (Argonne National Lab., IL). pp 99-107 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

The molybdenum content of the noble-metal alloy inclusions found in the columnar grain region of irradiated oxide fuel is shown to be a function of the centerline temperature and the initial stoichiometry of the oxide. The formation of gaseous $Cs_2MoO_4$ in the columnar-grain region and its transport to the cooler regions of the fuel are suggested to account for the observed dependence of the molybdenum content of the alloy inclusions on temperature and oxygen-to-metal ratio. The formation of cesium uranate in the axial blanket pellets, which can lead to swelling and rupture of the cladding, is discussed in relation to the initial stoichiometries of the fuel and blanket pellets. The formation of cesium molybdate (solid or liquid) and the oxygen potential of the fuel are shown to establish the cesium partial pressure in the fuel at the fuel/blanket interface. The cesium partial pressure and the stoichiometry of the urania blanket pellets determine the extent that cesium uranate forms. The onset of pressure on the cladding is quantitatively related to the stoichiometry of the urania pellets and the smear density. (auth)

**28429** NUCLEATION AND GROWTH OF FISSION GAS BUBBLES. Hayns, M. R.; Bullough, R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 217-231 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

A theoretical model is presented for the nucleation and growth of gas bubbles and the subsequent release of gas to grain boundaries. The method is based on the rate-theory approach, but without the usual simplifying assumptions of steady-state conditions. This allows a detailed discussion of the nucleation of the gas bubbles and shows that nucleation requires considerably longer than had previously been thought. Various assumptions are made, the main ones being that nucleation occurs homogeneously and that resolution occurs by the single knock-on method proposed by Nelson. It is shown that the bubble size distribution function is very sensitive to both temperature and resolution rate. In order to provide a description of the long-term gas release, a steady-state rate theory was used which is suitably joined to the dynamic theory. This gives gas release rates to grain boundaries which are consistent with experimental results. The mechanisms involved are highlighted and the effects of temperature, resolution and grain size are described. The results show that an understanding of the role of gas bubbles during transient and accident conditions is strongly dependent upon a knowledge of the distribution of gas within bubbles and on grain boundaries. (auth)

**28430** MASS TRANSFER IN THE PLUTONIA/IRIDIUM SYSTEM. Goldenberg, N. (Atomic Energy Commission, Washington, DC); Alexander, C. A.; Kent, R. A. pp 123-131 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

Iridium and $PuO_2$ mass transport have been observed where $PuO_2$ is contained in vented iridium shells at 1700°K in vacuum. The iridium transport can block the vent and preclude the helium from being released, which would lead to rupture of the shell. The transport can be explained by reaction of oxygen impurities in the iridium or oxygen from the $PuO_2$. Vapor transport of $PuO_2$ has been observed to preclude helium migration through the vent in a continuous mode. The helium is released in randomly spaced short bursts. (auth)

**28431** EQUATION OF STATE FOR $UO_2$ FOR FAST REACTOR CONTAINMENT STUDIES. Allan, J. W. S.; Hoskin, N. E.; Morris, E.; White, P. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 253-267 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

A form for a practical constitutive relation is described covering behavior from a shocked dense solid to heated liquid (although an explicit solid-liquid transition is not included), also including the two-phase liquid-vapor coexistence region. Data are defined on a reference curve which includes the Hugoniot (defining the compressive behavior under shock loading from normal density), the zero-pressure line between normal density and the boiling point, and the complete saturation curve. Along this reference curve values of several thermodynamic variables are listed for a standard set of values of specific volume. Thus updating of the data is an extremely simple matter. The methods of extrapolating away from this reference curve are described and discussed. New experimental data obtained at Aldermaston for inclusion in this form of relation are also presented together with a description of the experimental techniques used to obtain this data. (auth)

**28432** EQUATION OF STATE FOR LIQUID $UO_2$ USING THE THEORY OF SIGNIFICANT STRUCTURES. Gillan, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 269-285 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Theoretical discussions of the equation of state of $UO_2$ have in the past been based on corresponding-states methods. The empirical data used in these methods are derived from measurements on materials with low melting points, for example organic substances. Since $UO_2$ is believed to be ionic, the intermolecular forces must be entirely different from those present in organic materials; this fact casts doubt on the validity of the corresponding states work. An entirely different theoretical method is proposed. This is based on the significant-structures theory of Eyring, which is used to derive the thermodynamic properties from a consideration of the molecular structure of the liquid. The assumption of this theory is that the thermodynamic partition function for the liquid may be expressed as an average of the partition functions for the solid and the gas. The functional form of the average contains three free parameters which are determined by requiring agreement with selected experimental data. It is required that the pressure at the triple point, volume change on melting and entropy of fusion should be correctly given. In order to confirm that the theory can reasonably be applied to ionic substances, thermodynamic properties of the liquid-vapor line for alkali halides as well as for $UO_2$ have been calculated. A comparison with the experimental data for alkali halides shows good agreement. For $UO_2$ the results are compared with those of a corresponding-states treatment. (auth

**28433** INVESTIGATION OF THE ULTRA-HIGH TEMPERATURE AND PRESSURE STATE OF $UO_2$. Asami, N.; Nishikawa, M.; Taguchi, M. (Mitsubishi Atomic Power Industries, Inc., Saitama, Japan). pp 287-294 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Measurements of the vapor pressure of $UO_2$ at ultra-high temperatures are made using the new experimental approach. A giant-pulse ruby laser beam is focused on the sample for generation of the ultrahigh temperature state. The temperature is controlled by the energy density of the laser irradiation. The impulse of the vapor ejection is determined from oscillation angle of a torsion pendulum. The time dependence of the vapor ejection force is measured by a piezoelectric gage. Since the impulse is a product of the force and time, the vapor pressure can be determined from these observations and the ejection area. The minimum and maximum values of the measured pressures are about 150 and 13,000 atm, respectively. If the measured pressure is plotted against the reciprocal of the energy density, the pressure in the above region is approximated by the formula $P = P_0 \exp(-\alpha/\epsilon)$. Here, P and $\epsilon$ are the measured pressure and the irradiation energy density, respectively, and $P_0$ and $\alpha$ are the constants. Different sets of $P_0$ and $\alpha$ are fitted, corresponding to the three pressure regions, <640, 640 to 2300, and >2300 atm. The vapor temperature is determined from the measurement of relative emission intensities of the spectrum lines. The spectroscopic results of the laser-induced vapor have a low signal-to-noise ratio and self-absorption sometimes occurs. Therefore, a temperature measurement is made for limited cases. The maximum temperature is ~10,000°K at a vapor pressure of about 11,000 atm. The correlation between measured vapor pressure and temperature is considered to be consistent with the semi-theoretical equation of state of $UO_2$. (auth)

**28434** EVAPORATION EXPERIMENTS TO DETERMINE THE VAPOR PRESSURE OF $UO_2$ FUEL (3000 TO 5000°K). Bober, M.; Karow, H. U.; Schretzmann, K. (Kernforschungszentrum, Karlsruhe, Ger.). pp 295-305 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

An experimental technique to determine the vapor pressure of refractory fuel materials in the temperature range 3000 to 5000°K is described. The method is based on laser-beam heating of the specimen surface to a particular temperature and measurement of both the recoil momentum of the specimen and the mass and momentum carried away by the vapor jet flowing into a vacuum. It is shown that determination of the vapor pressure requires application of gas dynamics and development of a suitable model. First results for the vapor pressure of $UO_2$ determined with this method are reported. (auth)

**28435** THEORETICAL EQUATION FOR THE DIFFUSION-CONTROLLED IRRADIATION CREEP OF CERAMIC NUCLEAR FUELS: EFFECTS OF STOICHIOMETRY AND SOLUTE DRAG. Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). pp 371-383 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

The creep of both metallic and ceramic materials accelerates when they are irradiated or fissioned in a reactor. Of various theories for the irradiation creep of metals and alloys, one has recently been put forward which promises to systematize a significant proportion of the extant experimental data. A very general model of the dislocation-creep process is used, based on one which has successfully rationalized the out-of-reactor creep of a number of solids, including $UO_2$. According to the present development of this model, irradiation increases the dislocation-density until the rate at which the dislocation-network coarsens becomes high enough to produce a compensating reduction in the dislocation-density. The driving force for network-coarsening is the dislocation-line tension and the coarsening rate given by the Einstein equation relating the drift of the climbing dislocations to the relevant diffusion coefficient $D_V$. The theoretical equation has been solved for pure stoichiometric $UO_2$ under irradiation. An irradiation-creep rate of about 2 elastic deflections per displacement per atom is predicted and this is in reasonable agreement with the results of experiment. The kinds of prediction which the equation produces for conditions which have not been explored experimentally are also examined. These include the effects of stoichiometry or solute concentration which accelerates the out-of-reactor creep rate by a factor S, theoretically accelerates the in-reactor creep rate by a factor $S^4$. (auth)

**28436** STUDY OF THERMALLY-INDUCED DIFFUSION: APPLICATION TO H DIFFUSION IN Zr AND O DIFFUSION IN $UO_2$ AND $(U,Pu)O_2$. de la Tijera, J. S. (Instituto Nacional de Energia Nuclear, Mexico City). pp 385-395 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

The thermal diffusion of hydrogen in zirconium is discussed on the basis of three models: irreversible thermodynamics, the Wirtz model and Girifalco's model; previous results are analyzed on this basis. The thermal diffusion of oxygen in $UO_2$ and $(U,Pu)O_2$ solutions is also analyzed on the basis of the same criteria. (auth)

**28437** U SELF-DIFFUSION IN UC: EFFECTS OF DEVIATIONS FROM STOICHIOMETRY, REACTOR IRRADIATION, AND IMPURITIES. Matzke, H.; Routbort, J. L. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). pp 397-407 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Self-diffusion measurements were made with $^{233}U$ as the tracer using the $\alpha$-degradation technique in pure stoichiometric zone-refined single crystals of UC and in arc-cast UC with various carbon-to-uranium (C/U) ratios between 0.93 and 1.16 in the tem-

perature range of 1400°C to the melting point. These results and other published values of the uranium diffusivity in UC clearly show the existence of two diffusion processes; a high-temperature, vacancy-controlled mechanism and a low temperature extrinsic process probably controlled by metallic impurities, since recent work on (U,Pu)C shows that the effects of less than 2.5 at.% oxygen and nitrogen on self-diffusion is small. This interpretation, which explains some of the scatter in the earlier diffusion studies as well as the variations in the activation energy for creep is confirmed by investigating $^{233}U$ diffusion in UC doped with nickel, iron, tungsten, tantalum, and vanadium in different concentrations. In all cases an enhancement of uranium mobility is observed which increases as temperature decreases, but is approximately constant at high temperatures. The activation energy in the high-temperature region increases from 3.8 eV/at. to 7.6 eV/at. as the C/U-ratio increases from 0.93 to 1.07. This may be explained by the increase in binding energy as excess carbon is added. In pure $UC_{1.00}$ at a fission rate of $10^{13}$ fissions/cm$^3$ · s, fission enhanced diffusion will dominate below ~1500°C, whereas it will only dominate below ~1050°C for (U + 1.90 wt% W)$C_{1.00}$. The combination of varying C/U-ratio, impurity levels, and fission rate can change the uranium mobility over many orders of magnitude. (auth)

**28438** STUDY OF PARTIAL THERMODYNAMIC AND DIFFUSION CHARACTERISTICS OF SOME TRANSITION METAL CARBIDES. Andrievskii, R. A.; Spivak, I. I.; Khromov, Yu. F.; Khromonozhkin, V. V. (Inst. of Atomic Energy, Moscow). pp 409-414 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Results of a study are described of the partial vapor pressure of components over zirconium carbide and an investigation into the self-diffusion of metal and carbon atoms in zirconium and niobium carbides is reported. Data are also presented on the effective diffusion coeffcients, which were estimated on the basis of experiments on zirconium carbide and titanium carbide creep. The concentration variation of these parameters in the region of carbide homogeneity are analyzed and various approaches are discussed by which the effect of structural defects on diffusion and thermodynamic properties can be described. (auth)

**28439** PREDICTION OF CREEP BEHAVIOR FROM DIFFUSION DATA IN $UO_2$ NUCLEAR FUEL. Burton, B. (Central Electricity Generating Board, Berkeley, Eng.). pp 415-434 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

The applicability of the diffusion creep equation for predicting the thermal creep behavior of $UO_2$ reactor fuel is considered in detail. Increased creep rates are shown to occur in non-stoichiometric material but these can all be accounted for within the framework of the existing theory in terms of the increases in diffusion coefficient with O/U ratio. Comparisons are made between creep rates measured experimentally and those predicted from tracer diffusion data on hyperstoichiometric $UO_2$. At lower temperatures the linear relationship between creep rate $\dot{\varepsilon}$ and stress $\sigma$ is lost and the creep equation becomes increasingly inaccurate in predicting creep behavior. In order to obtain agreement between experiment and theory it is necessary to include a further term in the equation. This term takes the form of a threshold stress $\sigma_0$, below which diffusional creep does not contribute to strain, such that $\dot{\varepsilon} \propto (\sigma - \sigma_0)$. Two other creep contributions have been detected which could not be described by the diffusion creep equation nor by any extension or modification of it. The first of these was the existence of a transient creep component which was reversible on stress removal. This creep component has been attributed to the existence of intragranular dislocation links which provided internal sinks and sources for vacancies. Under an applied stress diffusion between these sources and sinks lead to diffusional strain. Such strain is reversible on stress removal since the bowed dislocations return to their new equilibrium configuration. The other additional creep component arose because of the existence of intergranular cavities remaining in the material from the manufacturing process. The stress-enhanced sintering of those cavities situated on boundaries normal to the compressive axis led to a diffusional creep strain. These observations are discussed. (auth)

**28440** COMPRESSIVE CREEP OF HYPOSTOICHIOMETRIC $UO_2$ AND $(U,Pu)O_2$ NUCLEAR FUEL PELLETS. Javed, N. A. (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). pp 435-446 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

The steady-state compressive creep rates of UO/sub 2-x/ and $(U_{0.75}Pu_{0.25})$O/sub 2-x/ fuel pellets were measured as a function of temperature (1400 to 1700°C), stress (1-12) x $10^3$ lbf/in$^2$, and oxygen-to-metal ratio (2.000 to 1.975 for urania and 1.985 to 1.903 for the mixed oxide). The density and grain size for the two types of oxide pellets were similar, i.e. 95 percent TD and 10 to 13 mu m, respectively. The dependence of creep, for a fixed O/M ratio, on stress and absolute temperature may be described by the linear superposition of a viscous flow and power-law creep relation. Inasmuch as the effect of O/M ratio was concerned, for UO/sub 2-x/ at 1700°C, the creep rate decreased with the decrease of O/M ratio in the range of oxygen-to-uranium ratios of 1.975 to 2.000. The effect of O/M ratio on creep rates in the linear-stress as well as in the power-law regions was the same. The apparent activation energy in the linear-stress region was calculated to be 81 +- 3 kcal/mol for $UO_{2.000}$ and 118 +- 4 kcal/mol for $UO_{1.975}$. In the case of mixed-oxide fuel pellets, at 1550°C the creep rates increased with decreasing O/M ratio from 1.985 to 1.903. The apparent activation energies in the low-stress region for an O/M ratio of 1.985 was 128 +- 6 kcal/mol and 73 +- 5 kcal/mol for an O/M ratio of 1.903. The creep behavior of the two oxides has been explained on the basis of a cation diffusion model. (auth)

**28441** SURFACE DIFFUSION OF Pu ON $UO_2$. Furuya, H.; Koizumi, M. (Power Reactor and Nuclear Fuel Development Corp., Tokai). pp 447-456 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

The surface diffusion coefficient of plutonium on uranium dioxide was measured over the temperature range from 1400 to 1830°C using a tracer method. A $(U,Pu)O_2$ needle acting as a point source of plutonium was placed on the polished surface of a $UO_2$ diffusion pellet and heated. The product, $D_s \cdot \delta$, in cubic centimeters per second, of the surface diffusion coefficient and the depth of surface diffusion layer could be expressed, in two (slightly overlapping) temperature ranges, by the following equations: $D_s \cdot \delta = 4.33 \times 10^{-4} \exp(-68{,}000/RT)$ for the range 1400 to 1670°C, and $D_s \cdot \delta = 2.95 \times 10^{8} \exp(-172{,}000/RT)$ for the range 1640 to 1830°C. (auth)

**28442** SELF-DIFFUSION OF Pu IN $(U,Pu)O_{2-x}$: ROLE OF THE O POTENTIAL AND THE Pu CONTENT. Schmitz, F.; Marajofsky, A. (CEN, Fontenay-aux-Roses, France). pp 457-468 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975). (In French).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

The diffusion of plutonium was measured in $(U_{1-y}, Pu_y)O_{2-x}$ at 1510°C for plutonium contents of 0, 0.04, 0.10, 0.15, 0.20, and 0.30. The oxygen potential was established by effecting the diffusion reheatings under a gaseous $CO-CO_2$ mixture. There were three series of experiments, corresponding to $CO/CO_2$ ratios of $10^2$, $10^3$, and $10^4$. The results can be described by a linear relation between the logarithm of the diffusion coefficient and the ratio x/y. This shows that the diffusion coefficient is not simply a function of the divergence from stoichiometry but rather of the ratio x/y, which expresses the probability that the plutonium is in the reduced state. In explaining the result, it is postulated, on the basis of thermodynamic and electrical data, that a complex structural defect exists which characterizes the oxygen-deficient domain of the mixed oxide. This defect consists of a molecule of $Pu_2O_3$ and an oxygen vacancy, and it is stabilized by a linkage of the covalent type. For the diffusion, an interstitial ring mechanism is proposed which results in a change of place of uranium and plutonium atoms. This mechanism implies that two plutonium atoms always remain in close proximity to an oxygen vacancy and that the migration of the uranium is in the opposite direction to that of the plutonium. (auth)

**28443** SYSTEMATIC THERMODYNAMIC PROPERTIES OF ACTINIDE METAL-OXYGEN SYSTEMS AT HIGH TEMPERATURES: EMPHASIS ON LOWER VALENCE STATES. Ackermann, R. J. (Argonne National Lab., IL); Chandrasekharaiah, M. S. pp 3-26 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

Thermodynamic data for actinide metals and oxides (thorium to curium) were assessed, examined for consistency, and compared with the lanthanides. Correlations relating the enthalpies

of formation of the solid oxides with the corresponding aquo ions make possible the estimation of the thermodynamic properties of $AmO_2$(s) and $Am_2O_3$(s) which are in accordance with vaporization data. The known thermodynamic properties of the substoichiometric dioxides MO/sub 2-x/(s) at high temperatures demonstrate the relative stabilities of valence states less than 4+ and lead to the examination of stability requirements for the sesquioxides $M_2O_3$(s) and the monoxides MO(s). Sequential trends in the gaseous metals, monoxides and dioxides are examined, compared, and contrasted with the lanthanides. (auth)

**28444** THEORETICAL STUDIES OF POINT-DEFECT PROPERTIES OF $UO_2$. Catlow, C. R. A.; Lidiard, A. B. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 27-43 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Calculations are reported on the energies of defects important both for stoichiometric and non-stoichiometric crystals. These are performed using computer simulation techniques using an ionic model for the crystal. Results confirm the simple models for the defect structure suggested by transport and neutron-diffraction data: anion Frenkel disorder predominates over Schottky and cation Frenkel disorder; oxidation leads to the introduction of $O^{2-}$ interstitials and $U^{5+}$ cations, which cluster to give structures closely related to those found in other anion excess fluoride phases. However, alternative analyses are suggested of certain of the experimental diffusion studies, leading to the prediction of higher defect formation energies—a prediction supported by calculations. Also the value calculated for the hole-electron disorder reaction of ~2 eV is lower than that for any other defect pair. This is important in the discussion in which the partial molar entropies and enthalpies of oxidation of $UO_2$ are calculated using a simple mass action model. The inclusion of electronic disorder is shown to be essential if the main features of the experimental work are to be explained. (auth)

**28445** INTERPRETATION OF PROPERTIES OF AND LATTICE DEFECTS IN $UO_2$ AND $PuO_2$ ON THE BASIS OF A COVALENT MODEL FOR OXIDES. Blank, H. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). pp 45-69 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Arguments are presented, based on the spectroscopic theory of the ionicity, that metal oxides should in most cases be treated as covalent compounds with regard to their crystal radii. It is shown that most 5f fluorite-type oxides should not be stable in the ionic picture. A covalent lattice model for these oxides is proposed and the tetrahedral covalent radius of oxygen is reduced. A discussion of the covalent lattice geometry and of some geometrical aspects of point defects and of dislocations in $UO_2$ and $PuO_2$ is given. (auth)

**28446** SOLUTION AND REACTION THERMODYNAMICS OF HYDROGEN WITH SELECTED FUSION REACTOR MATERIALS. Maroni, V. A. (Argonne National Lab., IL); Veleckis, E.; Cafasso, F. A.; Herrick, C. C.; Feber, R. C. pp 95-112 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

Experimental data on the thermodynamic properties of solutions of hydrogen, deuterium, and tritium in liquid lithium, and calculated stabilities of four insulator materials toward atomic and molecular hydrogen are reported. The significance of the results is discussed with regard to problems that are pertinent to the development of controlled thermonuclear fusion reactors. Values are given for equilibrium constants, free energies of formation, and Sieverts' Law parameters in the binary systems Li-H, Li-D and Li-T. The observed isotope effects in these systems appear to originate predominantly from the gas phase. Calculations of the stability of alumina, beryllia, and boron nitride in a molecular hydrogen environment, typical of a theta-pinch confined fusion plasma, indicate that all three materials would: (i) perform satisfactorily at 1100°K; (ii) show modest reaction at 1500°K; and (iii) be unsuitable at 2000°K. In a hydrogen-atom environment, all three materials are found to be unsatisfactory over the temperature range studied (1100 to 2000°K). (auth)

**28447** CONSTITUTIONAL STUDIES ON U-Pu-C-FISSION PRODUCT SYSTEMS: WITH APPLICATION TO THE PREDICTION OF THE CHEMICAL STATE OF IRRADIATED CARBIDE NUCLEAR FUELS. Haines, H. R.; Potter, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 145-173 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

For an understanding of the chemical constitution of an irradiated carbide nuclear fuel, a knowledge of the phase relationships of the individual fission product elements with uranium-carbon and plutonium-carbon is required. Experimental data for the phase diagrams of uranium-carbon, and plutonium-carbon with lanthanum, cerium, praseodymium, and neodymium are presented. Data for the uranium-carbon-gadolinium and yttrium systems are also given. Although there are no lanthanide monocarbide phases analogous to uranium and plutonium monocarbides there is limited solubility of the lanthanides in the actinide monocarbides; this solubility increases with increasing atomic number of lanthanide. The same tendency is observed for the limited solubility of the lanthanides in uranium sesquicarbide. There are regions of complete miscibility between plutonium and the lanthanide sesquicarbides. Limited data for the dicarbide region indicate that the high temperature cubic dicarbide phase can be quenched to room temperature in the uranium-lanthanum, -cerium, -praseodymium, and -neodymium dicarbide systems and in the plutonium-lanthanum dicarbide system. Isothermal sections for the complete phase diagrams are presented. Experimental data are also presented for the plutonium-Group VIII-fission product-carbon systems, the fission product elements being ruthenium, rhodium, and palladium. No ternary compounds analogous to $U_2RuC_2$ were found but the carbon-filled $Cu_3Au$ structured compounds, $PuRu_3C$ and $PuRh_3C$, were found. Using the phase diagram data presented together with existing phase equilibria data for the fission product elements not considered, the change in overall carbon potential of fuel compositions $U_{0.8}Pu_{0.2}C$ and $U_{0.8}Pu_{0.2}C_{1.03}$ after irradiation to 10% burnup has been calculated. For the composition $U_{0.8}Pu_{0.2}$, containing just a trace of sesquicarbide, the carbon potential falls during burnup, while that containing the larger amount of sesquicarbide has almost the same carbon potential after burnup as in the initial condition. (auth)

**28448** DATA FROM THE EXPERIMENTAL INVESTIGATION OF THE PHASE STRUCTURE OF ALLOYS AND THE PHASE DIAGRAMS OF THE U-C-Mo (W, Cr, Re) SYSTEMS. Alekseeva, Z. M.; Ivanov, O. S. (Inst. of Metallurgy, Moscow). pp 175-184 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

The interaction of uranium carbides with transition metals of groups VI and VII is characterized by the formation of a ternary compound of the $UMeO_2$ type with a rhombic lattice($UCrC_2$, $UMoC_2$, $UWC_2$, $UMnC_2$, $UTcC_2$, $UReC_2$). However, the tendency of uranium carbides to form ternary chemical compounds with transition metals of groups VI and VII is not limited to this: carbon-deficient compounds of the $UMeC_{2-x}$ type with a monoclinic lattice are formed in the U-Mo-C and U-W-C systems. A similar compound in the U-Re-C system was found. Ternary compounds with a tetragonal lattice were also discovered in the U-W-C and U-Cr-C systems, in the $UMeC_2$-MeC composite region, and in the U-Re-C system, in the $UReC_2$-UC composition region. A comparative analysis was performed of the elementary cell volumes of the ternary compounds. It is possible that not all ternary compounds have been discovered in the ternary systems described. In the region of ternary systems within which the absence of ternary compounds has been established with certainty, a study was made in order to ascertain the nature of the phase equilibria. In the U-Mo-C, U-W-C, and U-Cr-C systems, the nature of the crystallization of alloys was ascertained in the U-UC-$UMoC_2$-$Mo_2C$-Mo, U-UC-$UWC_2$-W, and UC-$UCrC_2$-$Cr_7C_3$-Cr regions, respectively. (auth)

**28449** INTERACTION OF Cs WITH $UO_2$ AT LOW O PRESSURES AT TEMPERATURES BETWEEN 600 AND 1000°C. II. Investigations on Cesium Uranates. Cordfunke, E. H. P. (Reactor Centrum Nederland, Petten). pp 185-192 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

The phase relationships in the Cs-U-O system are described. The phase which exists at low oxygen pressures and at temperatures between 500 and 1000°C is $Cs_2U_4O_{12}$. Its thermal stability depends on the oxygen potential of the system, and it decomposes via two reversible phase transitions into $UO_{2+x}$. The structural

relationship between $Cs_2U_4O_{12}$ and $UO_2$ is discussed. The thermochemical stability as a function of temperature was investigated by means of emf measurements. (auth)

**28450** THERMODYNAMICS OF THE INTERACTION OF $UO_2$ AND UN WITH METALS. Zagryazkin, V. N.; Panov, A. S.; Ushakov, B. F.; Fiveiskii, E. V.; Bobkov, B. N. (Physical-Power Inst., Obninsk, USSR). pp 193-211 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

It is shown that the interaction of non-stoichiometric $UO_{2+x}$ and $UN_{1-x}$ with molybdenum, tungsten, tantalum, and niobium is accompanied by the formation of oxides and solid solutions of oxygen and nitrogen in these metals. The maximum permissible deviations are determined from stoichiometric composition at which the interactions set in. The fact is established that a transfer of components from non-stoichiometric compounds takes place when a variable source is used. With the passage of time the component flows achieve equilibrium and the composition of the compound ceases to vary. The stable compositions calculated for non-stoichiometric uranium compounds lie in the pre-stoichiometric region. (auth)

**28451** TERNARY PHASE EQUILIBRIA IN THE SYSTEMS ACTINIDE–TRANSITION METAL–CARBON AND ACTINIDE–TRANSITION METAL–NITROGEN. Holleck, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 213-264 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Isothermal sections in the ternary phase diagrams of actinide–transition metal–carbon and actinide–transition metal–nitrogen systems are compiled on the basis of new phase studies, using thermodynamic data of carbides and nitrides, and considering the structure and lattice parameters of binary compounds. The lack of experimental results is compensated by estimating the solution behavior and the phase stabilities. Phase diagrams are given for the systems: Ti–(U or Pu)–C, U–(Th or Pu)–N, (Th or U or Pu)–C, (Th or U or Pu)–Ce–C, (Th or U or Pu)–Y–N, (Th or U or Pu)–Ce–N, U–(La or Ce or Pr or Nd)–N, (Th or U or Pu)–Ti–C, (Th or U or Pu)–Zr–C, (Th or U or Pu)–Nb–C, (Th or U or Pu)–Mo–C, U–(Ti or Zr or Hf or Mo)–N, (Th or Pu)–Zr–N, (Th or U or Pu)–Cr–N, and (Th or U or Pu)–(Ru or Rh or Pd)–C. Of particular interest is the occurrence of ternary carbides and nitrides. (auth)

**28452** PHASE EQUILIBRIUM CHANGES IN THE SYSTEM $UO_2$–$SiO_2$ DUE TO IRRADIATION UNDER CONDITIONS OF HIGH BURN-UP. Lungu, S.; Radulescu, O. (Inst. of Atomic Physics, Bucharest). pp 275-284 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In French).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Samples of $UO_2$–$SiO_2$ irradiated to a burnup of 20,000 MWd/t at 200–1500°C were examined microscopically and observations made of the following: changes in the dimensions and the volume fraction of the $UO_2$ crystals and in the structure of the spinodal mass; fission gas precipitation; and phase stability during irradiation. The growth of the grains and the smallness of the variation in the dimensions of the crystals and the fission gas bubbles suggest irradiation-induced diffusion. The single jump diffusion model was used to explain the value of the diffusion coefficients. The decreasing solubility of the fission gases with temperature may explain the threshold for the appearance of the fission gas bubbles. The possibility is noted of swelling which decreases with increasing hydrostatic pressure. (auth)

**28453** VAPORIZATION BEHAVIOR OF HYPOSTOICHIOMETRIC U–Pu–O AND U–Nd–O SOLID SOLUTIONS. Tetenbaum, M. (Argonne National Lab., IL). pp 305-320 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

Oxygen potentials over the U–Pu–O system, where Pu/(U + Pu) equals 0.2, have been established over the temperature range 2150 to 2550°K by means of a transpiration technique. These data are of particular importance since no data for the U–Pu–O system were previously available for this temperature range. The experimental oxygen potentials are approximately 10 to 15 kcal more positive than the previously accepted values obtained by extrapolation of lower temperature galvanic cell measurements. Values for the relative partial molar enthalpies and entropies of solution of oxygen are presented. Values of the partial pressure of actinide-bearing species have been calculated as functions of temperature and O/M ratio. Oxygen potentials for the U–Nd–O system, where Nd/(U + Nd) equals 0.1 and 0.2, are higher than those obtained with unalloyed urania, but lower than those indicated for the U–Pu–O system. The introduction of neodymium into the fluorite lattice appears to have a strong effect on the magnitude of the partial molar entropy and enthalpy of solution of oxygen. X-ray analysis of several U–Nd–O compositions showed only a single face-centered-cubic structure and a decrease in lattice parameter with increasing oxygen content. (auth)

**28454** TRANSPIRATION STUDY OF THE $UO_2$ VAPORIZATION PROCESS BETWEEN 2200 AND 2600°K. Benezech, G.; Coutures, J. P.; Foex, M. (CNRS, Odeillo, France). pp 337-346 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In French).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

A procedure is described for the transpiration study of substoichiometric uranium oxide vaporization. The experimental set-up involves a radiation concentration system (solar furnace or image furnace). The accent is placed on the practical aspect of the determinations, the technique employed making it possible to work on products subjected to very high thermal gradients. (auth)

**28455** DETERMINING THE FREE ENERGY OF ACTINIDE CARBONITRIDES USING AMORPHOUS CARBONS HAVING AN ARBITRARY DEGREE OF GRAPHITIZATION. Katsura, M.; Shohoji, N.; Yato, T.; Nomura, T.; Sano, T. (Osaka Univ.). pp 347-354 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

It is well known that solid solubility occurs between monocarbide and mononitride in the pseudobinary systems, ThC–ThN, UC–UN, and PuC–PuN. In these systems, there is an equilibrium state where carbonitride exists with free carbon under an atmosphere of nitrogen gas. It is a fundamental requirement that reliable thermodynamic data be obtained for these solid solutions in order to develop these carbonitrides as new nuclear fuels and to consider the changes in carbon and nitrogen potentials caused by changes in composition in these solid solutions due to burnup. A new method using carbon with an arbitrary degree of graphitization as the second phase existing with carbonitride is proposed for determining the relation between the compositions and carbon and nitrogen potentials in these carbonitrides. A thermodynamic analysis of the systems consisting of carbonitride and free carbon is presented. In order to survey qualitatively the applicability of this method, reactions of $U_{0.75}Ce_{0.25}N$ with graphite and of $U_{0.75}Ce_{0.25}N$ with an amorphous carbon have been studied experimentally. (auth)

**28456** THERMODYNAMICS OF HIGH-MELTING THREE-COMPONENT COMPOUNDS. Andrievskii, R. A.; Fedorov, E. M. (Inst. of Atomic Energy, Moscow). pp 367-378 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Expressions for the partial free energies of three-component carbide interstitial phases with allowance for concentration variation in the heat of formation of vacancies are examined. The congruent vaporization of the solutions are analyzed and it is shown that stable congruent vaporization can be expected in the case of solutions with short-range ordering. Expressions for the activities of the components in three-component systems are used to evaluate thermodynamic factors. The values of the latter are discussed in the light of the specific features of diffusion-controlled processes in three-component interstitial phases. (auth)

**28457** THERMODYNAMIC PROPERTIES OF MONOCARBIDES OF TRANSITION METALS. Zagryazkin, V. N.; Panov, A. S.; Fiveiskii, E. V. (Physical-Power Inst., Obninsk, USSR). pp 431-437 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

On the basis of published data and using the methods of statistical thermodynamics, the possibility of calculating partial thermal functions of transition metal monocarbide components is demon-

strated. The temperature dependences of the congruent vaporization of zirconium, hafnium, and niobium carbide are calculated. Questions of calculating the thermodynamic properties of complex carbides are considered in the regular approximation. The results are used in the thermodynamic analysis of a fuel composition based on uranium monocarbide with tungsten. (auth)

**28458** ENTHALPY OF FORMATION OF TITANIUM DIBORIDE. Akhachinskii, V. V.; Chirin, N. A. (Inst. of Atomic Energy, Moscow). pp 467-476 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

The values given in the literature for the enthalpy of the formation of titanium diboride, as obtained experimentally and by theoretical estimation, range between −32 and −74.4 kcal/mol. The method of direct synthesis from elements in a Calvet calorimeter was used to determine the enthalpy of formation, $\Delta H^{\circ}_{f,298}$, of titanium diboride with the composition $Ti_{1.000 \pm 0.002} B_{2.0184 \pm 0.006} C_{0.009} N_{0.003}$, which was found to be −76.78 ± 0.83 kcal/mol. It is calculated that $\Delta H_{f,298}$ ($TiB_{2.054}$) = −76.14 ± 0.85 kcal/mol. The procedure employed makes it possible to carry out the titanium diboride synthesis reaction with the calorimeter at room temperature. (auth)

**28459** HIGH-TEMPERATURE VAPORIZATION AND MASS SPECTROMETRIC MEASUREMENT OF THE EXTENT OF NON-STOICHIOMETRY IN OXIDE PHASES. Gilles, P. W.; Conard, B. R.; Sheldon, R. I.; Bennett, J. E. (Univ. of Kansas, Lawrence). pp 499-504 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

A new method has been devised for establishing the compositions of the lower phase boundary, the congruently vaporizing solution, and the upper phase boundary for high-temperature non-stoichiometric phases having significant ranges of homogeneity. The measurements are made at high temperature rather than on quenched samples. A two-phase sample of known composition is used. One of the phases is the non-stoichiometric one containing the particular composition at which congruent vaporization occurs; the other is the adjacent higher or lower phase. A weighed quantity is vaporized at constant temperature in a mass spectrometer until the congruently vaporizing state has been reached. The intensities of ions are measured during the entire experiment. The loss in mass, the initial composition, the intensities, and the times are used to obtain for the non-stoichiometric phase the compositions of the phase boundary and of the congruently vaporizing solution. The experiment is repeated with another sample whose initial composition is on the other side of the non-stoichiometric phase. The method is illustrated with results for the titanium–oxygen system in which the $Ti_3O_5$ phase contains the congruently vaporizing solution. (auth)

**28460** HIGH TEMPERATURE OXIDATION OF URANIUM DIOXIDE. Part II. Pressure and Temperature Dependence of the Oxidation Rate. Dharwadkar, S. R.; Karkhanavala, M. D. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem.; 13: No. 7, 685-688(Jul 1975).

The oxidation of $UO_2$ was studied in the temperature range 500° to 1000°C and oxygen partial pressure from 2 cm to 5 μ $pO_2$. At 1000° in the pressure range 2 to 0.1 cm $pO_2$, the specific reaction rate increased linearly with increasing pressure. In the low pressure range ($pO_2$ < 0.1 cm) the specific reaction rate varied as the square of the pressure. At a constant pressure depending on the magnitude of pressure, increase in temperature led to (i) insignificant increase in the reaction rate for bulk samples (pressure 0.1 cm $pO_2$), (ii) decrease in the reaction rate for bulk samples and (iii) slight increase in the reaction rate with temperature with the larger exposed area ($pO_2$ = 40 μ). This unusual dependence of the reaction rate on temperature has been explained. (auth)

**28461** COMPOSITION DEPENDENCES OF THE PROPERTIES OF SUPERCONDUCTING COMPOUNDS. Sal'nikov, B. V.; Men, A. N. (Inst. of Metallurgy, Sverdlovsk, USSR). Sov. Phys. - Solid State; 17: No. 1, 92-93(Jul 1975).

Translated from Fiz. Tverd. Tela; 17: No. 1, 158-160(Jan 1975).

The method of cluster components, applied to the composition dependences of the properties of superconducting compounds, made it possible to determine the presence or absence of the short-range order and to find the dependence of N(0) on the composition. The results obtained were in good agreement with the experimental data. (auth)

**28462** MAGNETIC AND ELECTRIC PHASE TRANSITIONS IN $V_2O_3$–$Ti_2O_3$ SOLID SOLUTIONS. Motornyi, A. V.; Tallerchik, B. A.; Teslenko, S. P.; Shustrov, B. S. Sov. Phys.-Solid State; 17: No. 1, 198-199(Jul 1975).

Translated from Fiz. Tverd. Tela; 17: No. 1, 324-325(Jan 1975).

The Mössbauer effect (nuclear gamma resonance) in the $^{57}Fe$ nuclei of the iron impurity atoms was used to study the magnetic phase transition in the $V_2O_3$–$Ti_2O_3$ system. Since the existence of a relationship between the electric and magnetic transitions is basic to the understanding of the phase transition in this system, the temperatures of the electric $T_e$ and magnetic $T_m$ transitions obtained for the same samples were compared. The concentration dependences of $T_e$ and $T_m$ for $(V_{1-x}Ti_x)_2O_3$ solid solutions indicated that as the $Ti_2O_3$ content increased, the transition temperatures decreased monotonically up to x = 0.04 [the hyperfine structure was not observed in the Mössbauer spectrum of a sample with the composition $(V_{0.95}Ti_{0.05})_2O_3$ right up to T = 80°K]. In the investigated range of the impurity concentrations the values of $T_e$ and $T_m$ were correlated. The lower value of the transition temperature for x = 0, compared with the general tendency of the concentration dependences of $T_e$ and $T_m$, was attributed to the presence of excess oxygen, known to suppress the antiferromagnetic phase. (auth)

**28463** METHOD OF PRODUCTION OF SPERICAL URANIUM DIOXIDE FUEL AND/OR BREEDER PARTICLES FOR NUCLEAR REACTORS AND BREEDER REACTORS. Nickel, H.; Foerthmann, R. (to Kernforschungsanlage Juelich GmbH). German (FRG) Patent 1,960,289/B/. 30 Jan 1975. 2p. (In German).

The method consists in hardening spherical drops of a uranium containing aqueous solution by a chemical reaction. The aqueous solution consists of uranyl nitrate, urea and hexamethylenetetramine and is dropped into a water insoluble liquid such as liquid paraffin. (GE)

**28464** NUCLEAR FUEL PARTICLES WITH A CORE OF FISSIBLE OR FERTILE MATERIAL AND METHOD OF PRODUCTION OF SUCH NUCLEAR FUEL PARTICLES. Chin, J.; Luby, C. S.; Mills, R. G. (to Hochtemperatur-Reaktor-Brennelement GmbH). German (FRG) Patent 1,915,670/B/. 6 Feb 1975. 10p. (In German).

5 figs.

The method deals with the coating of 4 layers on a fuel core: a first layer of pyrolytic carbon, the second layer of non-penetrable carbon, a third of dense silicon or zirconium carbide, as well as a fourth layer of dense pyrolytic carbon. The precipitation takes place in an atmosphere of hydrocarbons. (GE)

**28465** ACTIVATED SINTERING OF HIGH-REFRACTORY COMPOUNDS. Kislyi, P. S.; Kuzenkova, M. A. (Inst. for Development of Materials, Kiev). Sci. Sintering; 7: No. 1, 15-33(Jan 1975).

Activated sintering of high-refractory non-oxide compounds, and the effects of various physical and chemical factors on the shrinkage kinetics, are described. The sintering process is presented as a chemical reaction, but the degree of activation is determined quantitatively taking into account the change in temperature adequate to the maximum shrinkage rate during heating at a constant rate, or the change in the order of reaction during isothermal sintering. It is found that activation characterizes the initial stage and that it is caused either by changes in dispersion of powders, or by the heating rate up to the isothermal temperature, or by additives, or by the influence of the atmosphere or the vacuum. The influence of ultrasonic vibrations on the shrinkage kinetics is examined. In the initial sintering stage ultrasonic vibrations activate the process, but during a long-lasting influence, they deactivate it, causing decay of the structure. (auth)

**28466** SINTERING OF SOL-GEL MATERIAL. Bruijn, E. J.; Hamburg, F. W.; Kanij, J. B. W.; de Rooy, R. (to Reactor Centrum). Canadian Patent 971,355. 22 Jul 1975. Priority Date 17 May 1971, Netherlands. 7p.

An economic method for sintering spherical sol-gel material is reported. Spherical hexavalent oxidic uranium material, such as ADU or $UO_3$-hydrate, is converted into nuclear fuel of high density by means of a sinter stage, which consists in heating-up and cooling at a rate of 10–65°C/min. The sinter stage may be preceded by a preheating stage. Whereas the starting material may contain finely divided carbon. Previously only spherical sol-gel material of tetravalent uranium and pressed compacts of ceramic uranium dioxide powder were sintered with the above heating rates. Tetravalent uranium material has disadvantages with respect to hexavalent uranium material. (CA)

**28467** TUNNELING OBSERVATION OF THE SUPERCONDUCTING ENERGY GAP IN THE PALLADIUM HYDRIDE THIN FILMS. Igalson, J. (Inst. of Physics, Warsaw); Sniadower, L.; Pindor, A. J.; Skoskiewicz, T.; Bluethner, K.; Dettmann, F. Solid State Commun.; 17: No. 3, 309-312(1 Aug 1975).

Superconductivity in hydrogen-charged palladium thin films was studied. Using niobium-based tunnelling junctions, the energy gap in $PdH_x$ samples with different values of x and hence of $T_c$ was observed. (auth)

**28468** ELECTRICAL RESISTIVITY OF Pd–$H_x$. II. Phonon Resistivity. MacLachlan, D. S. (Univ. of Witwatersrand, Johannesburg); Mailfert, R.; Burger, J. P.; Souffache, B. Solid State Commun.; 17: No. 3, 281-285(1 Aug 1975).

The temperature-dependent phonon resistivity of the nearly stoichiometric Pd–H compound was measured. Results can be explained in terms of two phonon branches, an acoustical one primarily determined by the Pd lattice and an optical one determined by the hydrogen lattice. Some implications concerning the occurrence of superconductivity in this system were also drawn. (auth)

**28469** CRYSTAL-CHEMICAL EFFECT OF SPLAT-COOLING ON A 30 MOL % $CeO_2$ 70 MOL % $La_2O_3$ MIXED OXIDE. Foex, M.; Sibieude, F.; Rouanet, A.; Hernandez, D. (CNRS, Montlouis, France). J. Mater. Sci.; 10: No. 7, 1255-1257(Jul 1975).

It has been shown (Sibieude et al., Compt. Rend. Acad. Sci., Paris; 278 C: 1279 (1974)) that several intermediate phases result from the addition of $CeO_2$ to $La_2O_3$. Their formation appears to be related to the method of synthesis, i.e., co-fusion in air of oxides and an oxidizing anneal at 1500°C. In the present work a liquid-quenching method was used, by splat-cooling a mixed oxide whose initial composition was 30 mol% $CeO_2$ in $La_2O_3$. Results were compared with those on samples melted, cast and annealed at 1500°C. The preparation method is described. X-ray powder diffractograms are shown and the lattice parameters discussed. (UK)

**28470** TEMPERATURE DEPENDENCE OF THE HARDNESS OF SIMPLE AND COMPLEX CARBIDES OF TRANSITION METALS. Chezhik, L. N.; Semenov, A. P.; Ferenets, V. Ya.; Tret'akov, V. I.; Kushner, V. S. pp 82-87 of Temperature Microscopy of Metals and Alloys. Moscow; Izdatel'stvo Nauka (1974). (In Russian).

The hardness of the carbides TiC, ZrC, HfC, and WC and of TiC–WC, ZrC–WC, HfC–WC, TaC–HfC, HfC–TiC, and TaC–WC solid solutions is studied at room temperature and temperatures up to 950°C. It is found that, in all cases, the temperature dependence of the hardness in semilogarithmic coordinates can be expressed in the form of two straight lines that intersect at temperatures close to 400°C. For carbide solid solutions, the decrease in hardness at high temperatures is less pronounced than for monocarbides. (IAA)

**28471** NEW URANIUM BORIDES WITH THE STRUCTURE OF $YCrB_4$ TYPE. Val'ovka, I. P.; Kuz'ma, Yu. B. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 7, 652-655 (Jul 1975). (In Ukrainian).

X-ray diffraction analysis established the existence of new ternary uranium borides possessing crystal structure of the type $YCrB_4$: $UVB_4$ (a = 6.080; b = 11.48; c = 3.254 Å), $UCrB_4$ (5.928; 11.41; 3.497), $UFeB_4$ (5.786, 11.51; 3.451), and $UCoB_4$ (5.865; 11.42; 3.431). The obtained new borides $UMoB_4$, $UWB_4$, $UReB_4$, and $UNiB_4$ are not isostructural with $YCrB_4$. (auth)

**28472** ELECTRICAL RESISTIVITY OF Pd–$H_x$. I. Residual Resistivity. Burger, J. P. (Paris Univ., Orsay, France); Mailfert, R.; Souffache, B.; MacLachlan, D. S. Solid State Commun.; 17: No. 3, 277-280(1 Aug 1975).

Results are presented for the electrical resistivity of $PdH_x$ alloys at several fixed temperatures. The residual resistivity goes through a maximum at x = 0.73 and then drops sharply as x approaches 1. From this it was concluded that the residual resistivity for $0.8 < x < 1$ is due primarily to vacancies in the hydrogen lattice and that the hydrogen atoms occupy only the octahedral sites of the Pd lattice. Absolute values of the residual resistivity are in reasonable agreement with theoretical expectations. (auth)

**28473** ETHANOL DEHYDRATION ON DOPED CADMIUM OXIDE. Abd El-Salaam, K. M. (Assiut Univ. (Egypt). Dept. of Chemistry). Z. Phys. Chem. (Frankfurt); 95: No. 1-3, 129-138 (1975).

5 figs.; 4 tabs.; 14 refs.

The vapour phase catalytic dehydration of ethanol over Fe impregnated cadmium oxide was investigated between 200 and 450°C at atmospheric pressure. Electron transfer mechanisms involved in adsorption and catalytic dehydration reaction were investigated. The change in electrical conductivity of the catalyst resulting from calcination, adsorption, and surface reaction processes were studied. Adsorption conductivity at low temperature (< 200°C) indicates that ethanol adsorbs as an electron donor. A mechanism of creation of interstitial Cd atoms responsible for the catalytic dehydration of ethanol on the catalyst surface was suggested. (auth)

**28474** RADIATION STABILITY OF GLASSES AND OXYGEN-CONTAINING SOLIDS. Vorobbev, A. A.; Zavadovskaya, E. K.; Starodubtsev, V. A.; Vakhromeev, V. G.; Boev, S. G.; Sal'nikov, V. N. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 143-145(1975). (In Russian).

The lack of a physical theory for the radiation stability of glasses is discussed and the possibility of using the development of the ionic structure as a basis for the development of such a theory is considered. The development of surface charges under the influence of irradiation and its relation to the volume electric resistivity are discussed. (JSR)

**28475** EFFECT OF $\gamma$ RADIATION ON THE DIELECTRIC CHARACTERISTICS OF THE Al–$Si_3N_4$–Al SYSTEM. Burachevskii, Yu. A. (Tomsk Inst. of Automated Control Systems and Radioelectronics). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 124-126(1975). (In Russian).

The effects of $\gamma$ radiation on the dielectric properties of $Si_3N_4$ films were studied for the Al–$Si_3N_4$–Al system. The irradiation was made at exposure doses of 850 R/s at a temperature of 312 ± 5°K to a dose of $8.8 \times 10^8$ rad obtained in several steps. The irradiation caused the irreversible decrease of the capacitance, conductivity, and dielectric loss tangent. These changes were dependent on the thickness of the dielectric film. They were caused by processes occurring both in the dielectric and at the metal-dielectric boundary. (JSR)

**28476** PROTON NMR STUDIES OF SUPERCONDUCTING INTERCALATION COMPLEXES: ORIENTATION, ARRANGEMENT AND MOLECULAR DYNAMICS IN $TaS_2$ (COBALTOCENE)$_x$. Silbernagel, B. G. (Corporate Research Labs., Exxon Research and Engineering Company, Linden, New Jersey, USA). Chem. Phys. Lett.; 34: No. 2, 298-301(15 Jul 1975).

The orientation, arrangement, and temperature-dependent dynamics of cobaltocene molecules intercalated in the layered compound $TaS_2$ are determined by proton NMR observations. (auth)

## Metals and Alloys

*Refer also to abstracts 28379, 29875, 30123, and 30220.*

**28477** (ORNL-5106) MECHANICAL PROPERTIES TEST DATA FOR STRUCTURAL MATERIALS QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1975. Hill, M. R. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 330p. AT.

Test data on heat resisting structural materials are presented. These data were obtained in research conducted at Aerojet Nuclear Company, Argonne National Laboratory, Oak Ridge National Laboratory, Naval Research Laboratory, Westinghouse Advanced Reactors Division, University of Cincinnati, University of California at Los Angeles, and General Electric Company. (JRD)

**28478** (ORNL-TM-4940) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1975. Patriarca, P. (Oak Ridge National Lab., Tenn. (USA)). Jul 1975. Contract W-7405-eng-26. 232p. AT.

Advanced Absorber Materials: $Eu_2O_3$–W cermets with improved thermal conductivity were prepared. Thermal performance tests of $Eu_2O_3$ pellets under FTR conditions were successful. Irradiation of $Eu_2O_3$ in FTR is reported. Steam Generator Materials: Corrosion testing of 2¼ Cr–1 Mo steel in superheated steam and boiling water is reported. Tensile properties of 2¼ Cr–1 Mo steel at various strain rates and for various heats are reported. Results of fatigue, creep-fatigue, and subcritical crack growth studies on 2¼ Cr–1 Mo steel are given; development of mechanical property correlations continued. The bore-side inspection of tube-to-tubesheet joints is emphasized. Mechanical Properties and Behavior for Structural Materials: Creep and tensile properties after creep of Type 304 stainless steel (55) are reported. Effects of heat-to-heat variation and aging on creep and tensile properties of 304 and 316 ss were investigated. Parametric correlation and extrapolation of creep ductility data were applied to 5 heats of 304 and 316 ss. Material data processing activities are reported. Work

on determining the elastic properties of Cr–Mo steels is reported. Mechanical and Metallurgical Behavior of Weldments for LMFBR: Types 308, 316, and 16-8-2 ss welds with and without controlled residual elements are being characterized and evaluated; creep and creep-rupture properties are among the properties determined. (DLC)

**28479** (RDT-M-5-7T(9-75)) NICKEL–IRON–CHROMIUM ALLOY PLATE, SHEET, AND STRIP (ASME SB-409 WITH ADDITIONAL REQUIREMENTS). (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Sep 1975. 4p. RSO.

This standard covers Ni–Fe–Cr alloy plate, sheet, and strip for nuclear and associated applications. Analysis, testing, examination, etc. are covered. (DLC)

**28480** (RDT-M-7-10T(9-75)) NICKEL–IRON–CHROMIUM ALLOY ROD AND BAR (ASME SB-408 WITH ADDITIONAL REQUIREMENTS). (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Sep 1975. 3p. RSO.

This standard covers Ni–Fe–Cr alloy rod and bar forgings for nuclear and associated applications. Testing, examination, etc. are covered. (DLC)

**28481** (RDT-M-7-11T(9-75)) NICKEL–MOLYBDENUM–CHROMIUM ALLOY ROD AND BAR (ASME SB-336 WITH ADDITIONAL REQUIREMENTS). (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Sep. 1975. 4p. RSO.

This standard covers Ni–Mo–Cr alloy rod and bar for nuclear and associated applications. Heat treatment, analysis, testing, examination, etc. are covered. (DLC)

**28482** (RDT-M-31T(9-75)) STAINLESS STEEL CENTRIFUGALLY CAST PIPE (ASME SA-451 WITH ADDITIONAL REQUIREMENTS). (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Sep 1975. 4p. RSO.

This standard covers centrifugally cast austenitic steel pipe for nuclear and associated applications. Heat treatment, analysis, testing, etc. are covered. (DLC)

**28483** (SAND-75-0094) MAGMA/METAL COMPATIBILITY STUDY: COMPATIBILITY OF METALS IN MOLTEN DEGASSED THOLEIITIC BASALT. Sallach, R. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 28p. Dep. NTIS $4.50.

The compatibility of ten commercially available alloys with molten (1300°C) degassed tholeiitic basalt was studied. Results can be explained on the basis of (1) the relative free energies of formation of pertinent oxides and (2) shifts in the chemical equilibrium among iron species. (auth)

**28484** (STI/PUB-380(Vol.1)) THERMODYNAMICS OF NUCLEAR MATERIALS, 1974. Volume I. Proceedings Series. Proceedings of a Symposium Held in Vienna, 21–25 October 1974. (International Atomic Energy Agency, Vienna (Austria)). 1975. 469p. (In Several Languages). (CONF-741030-P1). IAEA $28.00.

Thirty-four papers are included in Vol. I. They concern properties of irradiated fuels, safety aspects of irradiated fuels and diffusion properties of nuclear fuels. (JRD)

*For abstracts of individual papers see: 28421–28442, 28610, 30185–30187, 30227–30229, 30368–30370, 30375, and 30430.*

## Corrosion and Erosion

*Refer also to abstracts 27629, 28729, 30227, and 30228.*

**28485** (BNWL-1901(Rev.1)) STATE OF THE ART REVIEW OF DEGRADATION PROCESSES IN LMFBR MATERIALS. Volume I. Mechanical Properties. Volume II. Corrosion Behavior. Revision 1. Dillon, R. L.; Levy, I. S. (comps.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 25 Aug 1975. Contract E(45-1)-1830. 46p. Dep. NTIS $5.50.

A revision to Volume I and Volume II of the LMFBR materials degradation summary is presented. Information is included on NaOH corrosive effects, effects of metal cleaning procedures, and caustic stress corrosion cracking of reactor materials. (JRD)

**28486** (BNWL-1901(Vol.2)) STATE OF THE ART REVIEW OF DEGRADATION PROCESSES IN LMFBR MATERIALS. Volume II. Corrosion Behavior. Dillon, R. D. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 7 Mar 1975. Contract E(45-1)-1830. 500p. Dep. NTIS $28.00.

Degradation of materials exposed to Na in LMFBR service is reviewed. The degradation processes are discussed in sections on corrosion and mass transfer, erosion, wear and self welding, sodium–water reactions, and external corrosion. (JRD)

**28487** (GA-A-13462) EFFECTS OF ELEVATED TEMPERATURE EXPOSURE TO A SIMULATED HTGR PRIMARY COOLANT ENVIRONMENT ON SEVERAL UNSTRESSED AUSTENITIC ALLOYS. Mazandarany, F. N. (General Atomic Co., San Diego, Calif. (USA)). 15 Aug 1975. Contract AT(04-3)-167. 88p. Dep. NTIS $5.45.

Coupon specimens of Incoloy 800, Hastelloy X, Inconel 600, Inconel 617, 304 stainless steel, and Hastelloy S were exposed at 1200, 1400, and 1600°F for up to 10,000 h to helium containing impurities at partial pressures similar to those that are expected to occur in the primary coolant of an HTGR during steady-state operation without steam or water leaks. The exposed specimens were subjected to metallographic and electron microprobe examinations for analysis of surface interactions. Exposure under the test conditions resulted in oxidation in the form of both scale and sub-scale attack. The scale was generally duplex (two-layer) with the outer layer being Cr rich and the inner layer rich in Al, Ti, Mn, or Si. The sub-scale attack was directional in growth and was rich in Al, Ti, or Si depending on the alloy. The experimental data indicate a decreasing rate of attack with increasing exposure time. In no case did the maximum depth of oxide penetration exceed 2 mils in 10,000 hr. No evidence of carbon transport into or out of the metals was found. A qualitative mechanistic model is advanced to account for the experimental observations. (auth)

**28488** (KFK-2137) APPLICATION OF THE SCANNING ELECTRON MICROSCOPE FOR THE STUDY OF SODIUM CORROSION AND MASS TRANSFER. Borgstedt, H. U.; Huber, H. J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Mar 1975. 36p. (In German). Dep. NTIS (US Sales Only) $5.00.

The scanning electron microscope is an instrument useful for the detection of morphological and chemical changes in material surfaces due to sodium corrosion and mass transfer. Some examples for the application of the scanning microscope and the x-ray spectrometer combined with it are presented. The capacity of the method to observe corrosion phenomena are discussed. (auth)

**28489** (ORNL-5047, pp 59-147) MATERIALS DEVELOPMENT. McCoy, H. E. Sep 1975.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1975. (Oak Ridge National Lab., Tenn. (USA)).

The main thrust of the materials program is toward the development of a structural material for the MSBR primary circuit which has adequate resistance to embrittlement by neutron irradiation and to intergranular cracking by fission product penetration. A modified composition of Hastelloy N containing 2 percent Ti is being tested. It may be necessary to further modify the alloy with rare-earth, niobium, or higher chromium additions. Laboratory programs to study Hastelloy N–salt–tellurium interactions are being established. The procurement of products from two commercial heats (8000 and 10,000 lb) of 2 percent Ti modified Hastelloy N has continued. Capsule tests are in progress to study possible chemical interactions between graphite and bismuth-lithium solutions and to evaluate the mechanical intrusion of those solutions into the graphite. Two thermal-convection loops are in operation in the new loop facility. An air lock was added to the general test facility to make it more functional. (JRD)

**28490** (ORNL-TM-4995) EFFECTS OF CHLORIDE AND CAUSTIC ON THE CRACKING BEHAVIOR OF SEVERAL MATERIALS UNDER ALTERNATE WET AND DRY STEAM CONDITIONS. Griess, J. C.; Hammond, J. P.; Maxwell, W. A. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 15p. AT.

The susceptibility of a number of alloys to stress-corrosion cracking in steam to which either chloride or caustic has been added was determined. U-bend specimens were alternately exposed to superheated steam and to saturated steam containing appreciable moisture. Since the solubility of sodium hydroxide in superheated steam is extremely low under the test conditions, caustic was added only during the saturated steam portion of the test cycle, and the maximum concentration was 100 ppM sodium hydroxide. All alloys tested in this environment--including low-alloy steels, types 410, 310, and 304 stainless steel, and high-nickel alloys--completely resisted cracking. In chloride environments either sodium or calcium chloride was added during both the superheated and saturated part of the cycle (maximum concentration, 10 ppM chloride). The oxygen concentration was 8 ppM. Both Hastelloy N and E-Brite 26-1 were very susceptible to crack-

ing. Incoloy 800 weldments in the as-welded condition cracked in this test, while Incoloy 800 base metal and postweld heat-treated specimens did not. Inconel 601 and 2¼ Cr–1 Mo steel resisted cracking, but a single crack developed in one specimen each of Inconel 600, Inconel 625, and Hastelloy X. (auth)

**28491** (REG/G-337(9-75)) GUIDANCE FOR AVOIDING INTERGRANULAR CORROSION AND STRESS CORROSION IN AUSTENITIC STAINLESS STEEL COMPONENTS OF FUEL REPROCESSING PLANTS. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Sep 1975. 8p. NUREG.

Recommendations are presented concerning prevention of intergranular corrosion and stress corrosion of austenitic stainless steel components of fuel reprocessing plants such as vessels, piping, process cells, and waste storage tanks. (JRD)

**28492** OXIDATION RESISTANCE OF BORONIZED IRON ALLOYED WITH VANADIUM. Trush, I. Kh.; Kirchev, B. S.; Atanasova, I. R. (Kiev Polytechnical Inst.). Met. Sci. Heat Treat.; 16: No. 9-10, 831-832(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 15-17(Oct 1974).

The FeB phase in the boride coating on iron alloyed with vanadium is stable up to 800° and the $Fe_2B$ phase up to 1000°. Vanadium (up to 1.5%) improves the oxidation resistance of iron boride. The microhardness of the boride phases remains unchanged at all temperatures where they remain stable. (auth)

**28493** CORROSION RESISTANCE OF TRIP STEELS. Baghdasarian, A. (Iranian Oil Co., Tehran); Ravitz, S. F. Corrosion; 31: No. 5, 182-184(May 1975).

Anodic polarization tests on certain metastable austenitic (TRIP) steels having very high strength and good ductility, with contents of sulfur, phosphorus, and other impurities comparable to those of commercial alloy steels, indicate they would have about the same general corrosion resistance as commercial Type 316 stainless steel and appreciably better resistance to pitting in sea water. Cold-working of a TRIP steel increased its resistance to pitting somewhat and decreased its indicated general corrosion resistance slightly; these effects appear to be due to the transformation of austenite to martensite as a result of the cold-working rather than to the cold-working itself. (auth)

**28494** METHOD OF ANODIC OXIDATION OF ZIRCONIUM NUCLEAR REACTOR STRUCTURAL COMPONENTS. Scharf, H.; Koehler, L. (to Siemens AG). German(FRG) Patent 1,496,994/B/. 13 Mar 1975. 2p. (In German).

The method concerns corrosion protection by surface passivation. It is characterized in that, prior to the anodic oxidation in 1N $H_2SO_4$ or 1N NaOH, a brief cathodic pretreatment ($H_2$ separation) is carried out, and that for the counter electrode, materials (such as graphite) are used which do not dissolve under anodic stress. (GE)

**28495** EFFECT OF PROTECTIVE COATINGS ON MOLYBDENUM ADHESION PROPERTIES. Evtushenko, O. V.; Braun, S. M. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 72-75(Jun 1975). (In Russian).

Adhesion interaction was studied between unprotected molybdenum with molybdenum protected by boride, carbide, and silicide coatings. Molybdenum begins interacting with unprotected molybdenum at 800°C. Interaction of molybdenum with borated, carbidized, and siliconized molybdenum was shown to begin at 1100°C. The lowest adhesion coefficient is observed at interaction of unprotected molybdenum with siliconized molybdenum. (auth)

**28496** STABILITY AND SOLUBILITY OF METAL OXIDES IN HIGH-TEMPERATURE WATER. Macdonald, D. D.; Rummery, T. E.; Tomlinson, M. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). pp 123-141 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Recent compilations of elementary thermodynamic properties of metal-water systems and derived quantities needed for optimum design and operation of nuclear steam generation equipment are summarized. Free energies of iron, cobalt, nickel, copper, and aluminum metal, oxides and ions in dilute aqueous solution at temperatures up to 300°C are tabulated. Derived data on potential-pH relations, solubilities, $H_2$ and $O_2$ equilibrium pressures for reduction and oxidation processes, and compound oxide formation are outlined. The practical significance is indicated. Needs for improved data are noted. (auth)

**28497** INTERACTION OF OXYGEN WITH THE (110) FACE OF MOLYBDENUM SINGLE CRYSTAL. Zykov, B. M.; Ikonnikov, D. S.; Tskhakaya, V. K. (Sukhumi Physicotechnical Inst., USSR). Sov. Phys. - Solid State; 17: No. 1, 163-166(Jul 1975).

Translated from Fiz. Tverd. Tela; 17: No. 1, 274-279(Jan 1975).

The low-energy electron diffraction method and a demountable metal diffractometer unit of planar geometry were used in a study of the structure of oxygen on the (110) face of a molybdenum single crystal. The change in the work function $\Delta\varphi$ was determined to within 0.02 eV by measuring the shift of the electron-beam current retardation curves (Anderson method). Hydrogen and oxygen were introduced in the form of molecular beams passed through palladium and silver filters, respectively. Oxygen was adsorbed at room temperature and at 600, 800, and 1000°C. The adsorbed oxygen structures were annealed in the temperature range 300 to 1600°C. The maximum change $\Delta\varphi$ during the adsorption of oxygen at room temperature was 1.35 eV. During the initial stage of adsorption the work function fell by 0.04 eV below its value for a clean face. Heating of the oxygen structures in the range 300 to 1100°C caused a slight increase of the work function by 0.05 to 0.07 eV, which was attributed to an increase in the mobility of oxygen atoms because of heating. Data indicated that the structure of the (110) face of Mo changed as a result of penetration of oxygen. One of the structures obtained in the final stage of adsorption was attributed to the oxide $MoO_2$, whose (110) face was oriented parallel to the substrate plane. The structure obtained by adsorption on a crystal heated to 800°C was attributed to the oxide $MoO_3$, whose (111) face was parallel to the substrate plane and which was faceted by the (100) planes. (auth)

**28498** CORROSION-ELECTROCHEMICAL BEHAVIOR OF METALS AND ALLOYS IN ACETIC ACID SOLUTION AND IN CONCENTRATED ACETIC ACID AT INCREASED TEMPERATURES. Tsinman, A. I.; Pischik, L. M.; Balieva, R. A.; Klochkova, M. R. Prot. Met. (USSR) (Engl. Transl.); 10: No. 6, 617-622(1974).

Translated from Zashch. Metal.; 10: No. 6, 677-683(1974).

The influence of the nature of the metal, the chemical composition of a number of steels and alloys, the temperature, and water content on the kinetics of the anodic dissolution of metals and the cathodic evolution of hydrogen in acetic acid solutions of sodium acetate was studied. The rate of corrosion of certain steels and alloys in concentrated (90-100%) acetic acid was determined at 118-250°. (auth)

**28499** HYDROGEN EMBRITTLEMENT OF NIOBIUM. Arons, V. I.; Migai, L. L.; Zhuk, N. P.; Rybakov, B. N. (Scientific-Research Inst. of the Rare Metals Industry, Moscow). Prot. Met. (USSR) (Engl. Transl.); 10: No. 6, 664-665(1974).

Translated from Zashch. Metal.; 10: No. 6, 729-731(1974).

The hydrogen embrittlement of Nb during cathodic polarization in HCl was investigated using multiple bending. The H content increases linearly during polarization; after 60 min, the H absorption slows down somewhat. The ductility begins to decline at 0.005% H, and embrittlement occurs at 0.030% H. The ductility reduction thus begins at a H content smaller than that at which the hydride phase appears. (DLC)

**28500** OXIDATION PROCESSES IN AIR OF NICKEL ALLOYS WITH 10% Cr ALLOYED WITH ZIRCONIUM AND HAFNIUM. Ryabkina, M. M.; Gil'dengorn, I. S.; Rogel'berg, I. L. (State Scientific-Research Inst. of Alloys and Manufacture of Nonferrous Metals, Moscow). Prot. Met. (USSR) (Engl. Transl.); 10: No. 6, 669-671(1974).

Translated from Zashch. Metal.; 10: No. 6, 734-738(1974).

An investigation was made of the effect of adding up to 1 at. % Zr and up to 0.7 at. % Hf on the rate and mechanism of oxidation of Ni–10% Cr during isothermal and cyclic heating in air. Isothermal oxidation was conducted at 1000 to 1200°C; resistance to alternate heating and cooling was also determined. The structure of the scale and the layers beneath were studied. A possible explanation for the protective effect of Zr additions, and for the non-protective effect of Hf additions, is offered. (DLC)

**28501** OXIDATION OF THORIUM, URANIUM, AND PLUTONIUM. Colmenares, C. A. (Univ. of California, Livermore). Prog. Solid State Chem.; 9: 139-239(1975).

The subject is dealt with in chapters entitled: chemical and physical properties relevant to the oxidation of Th, U, and Pu; possible oxides formed, their characteristics and properties (phase diagrams, thermodynamic properties, electrical properties, diffusion characteristics); the first oxidation stage (adsorption/chemisorption, work functions, LEED, photoelectron spectroscopy, Auger electron spectroscopy); oxide growth and oxidation kinetics. (UK)

**28502** FORMATION OF AN INTERNAL OXIDATION ZONE STRUCTURE IN COPPER-BASED ALLOYS. Bondar, M. P.; Gubareva, N. V.; Teslenko, T. S. (Inst. of Hydrodynamics,

Novosibirsk, USSR). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 95-104(1975). (In Russian).

The process of the formation of an internal oxidation zone structure during the diffusion of oxygen into binary Cu alloys with oxide-forming elements Al, Be, Ti, or Si and the effect of microadditions of a third element on this process were studied. It was shown that during the dispersal of internal oxidation zones the dimensions of the precipitate are increased. In the presence of preferred crystallographic directions of growth, needle-shaped precipitates are formed and microscopic striations arise in the structure. It was proposed that the change at the reaction front of the ratio of the quantity of oxygen atoms to the quantity of oxide-forming atoms in proportion to the advance of the front is the primary origin of these structural singularities. Microadditions of a third element (Ti in Cu–Al and Be, Ti, and Zr in Cu–Si) affects the nucleation process and increases the degree of dispersion of the precipitates. This affects the diffusion of the reacting elements and therefore the character of the structure formed. (tr-auth)

**28503** A COMBINED FIM, AES, AND LEED STUDY OF THE STRUCTURE AND COMPOSITION OF ION BOMBARDED TUNGSTEN SURFACES. Walls, J. M.; Martin, A. D.; Southworth, H. N. (Birmingham Univ. (UK). Dept. of Physical Metallurgy and Science of Materials). Surf. Sci.; 50: No. 2, 360-378(Jun 1975).

A number of experimental techniques were used to gain information on the structure and chemical composition of tungsten surfaces following low-energy ion bombardment using inert gases. Field-ion microscopy reveals the nature and depth distribution of the lattice defects that are formed, but is unable to determine whether any departure from true crystallinity was induced; neither can it detect whether the inert gas species becomes trapped. On the other hand, low-energy electron diffraction shows that the bombarded surface remains effectively crystalline, while Auger electron spectroscopy reveals the extent to which the different bombardment species become trapped, and the effect that such trapping has on the LEED patterns. In this way it has been possible to obtain a full description of the processes that occur, and to come to some conclusions regarding the relative effectiveness of the different ion species in sputter-cleaning metal surfaces. (auth)

## *Preparation and Fabrication*

*Refer also to abstracts 27528, 27571, and 29299.*

**28504** (BNL--20471) STABILITY OF A-15 COMPOUNDS IN MULTIFILAMENTARY SUPERCONDUCTING WIRES. Luhman, T.; Horigami, O.; Hughes, D. D. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 45p. (CONF-750840-2). Dep. NTIS $5.25.

From symposium on computer networking and chemistry; Chicago, Illinois, USA (24 Aug 1975).

With the pre-eminence of A-15 superconducting multifilamentary wires in magnet technology, it has become important to understand the thermodynamic factors influencing the formation of these compounds under solid-state reaction conditions. The six systems Nb–Sn, Nb–Ga, Nb–Ge, Nb–Al, V–Si, and V–Ga were prepared as single-filament bronze wires and heat treated in an attempt to precipitate the appropriate A-15 compound. The compounds observed to form were categorized using a formation temperature ratio (stability index) based on the melting temperatures of the constituents which make up the single filament composites. This study has led to several predictions regarding the formation of A-15 compounds using a solid-state bronze diffusion technique. Results of experimentation based on these predictions are presented. (auth)

**28505** (CONF-751016-1) FLAW-SIZE MEASUREMENT IN A WELD SAMPLE BY ULTRASONIC FREQUENCY ANALYSIS. Adler, L.; Cook, K. V.; Whaley, H. L. Jr.; McClung, R. W. (Oak Ridge National Lab., Tenn. (USA)). 1975. 30p. Dep. NTIS $4.50.

From conference of the American Society for Nondestructive Testing, Inc.; Atlanta, Georgia, USA (13 Oct 1975).

An ultrasonic frequency-analysis technique was developed and applied to characterize flaws in an 8-in. (203-mm) thick heavy-section steel weld specimen. The technique applies a multitransducer system. The spectrum of the received broad-band signal is frequency analyzed at two different receivers for each of the flaws. From the two spectra, the size and orientation of the flaw are determined by the use of an analytic model proposed earlier. (auth)

**28506** (LA-5970-MS) ELECTRON-BEAM WELDING OF 21-6-9 (Cr–Ni–Mn) STAINLESS STEEL: EFFECT OF MACHINE PARAMETERS ON WELDABILITY. Casey, H. (Los Alamos Scientific Lab., N. Mex. (USA)). Apr 1975. Contract W-7405-eng-36. 13p. Dep. NTIS $4.00.

The high-manganese, nitrogen-strengthened 21-6-9 (Cr–Ni–Mn) austenitic stainless steel has a weldability rating similar to that of more common austenitic stainless steels in terms of cracking, porosity, etc. However, weld pool disruption problems may occur with this alloy that can be related to instability within the molten weld pool. Selection of machine parameters is critical to achieving weld pool quiescence as this report confirms from recent tests. Test samples came from heats of air-melted, vacuum-arc remelted, and electroslag remelted material. Low- and high-voltage machine parameters are discussed, and effects of parameter variation on weld pool behavior are given. Data relate weld pool behavior to weld fusion-zone geometry. Various weld parameters are recommended for the 21-6-9 alloy, regardless of its source or chemistry. (auth)

**28507** (LA-UR--75-1605) FUSION WELDING OF THIN METAL FOILS. Casey, H. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 12p. (CONF-751017--4). Dep. NTIS $4.00.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

Aspects of fusion welding of thin metal foils are reviewed and the current techniques employed at LASL to join foils are described. Techniques for fusion welding approximately 0.025-mm-thick foils of copper, aluminum, and stainless steels have been developed using both electron beam and laser welding equipment. These techniques, together with the related aspects of joint design, tooling and fixturing, joint preparation, and modifications to the commercially available welding equipment, are included in the review. (auth)

**28508** (NLCO-1122) EFFECTS OF CARBON ON THE CONTROL AND DISTRIBUTION OF TITANIUM IN URANIUM-0.8 WT PERCENT Ti CASTINGS. Schardt, R. L.; Bauer, R. F.; Wise, W. N. (National Lead Co. of Ohio, Cincinnati (USA)). Mar 1975. Contract E(30-1)-1156. 25p. Dep. NTIS $4.25.

A series of small-scale U–0.8 wt percent Ti alloy castings (approximately 4 in. OD x 10 in. long) were made under conditions designed to produce ingots of varying carbon content. These ingots were destructively sampled to expose the longitudinal center line of each casting for a metallographic analysis and transversely sampled to give an edge-center, top-bottom, alloy-carbon distribution pattern. Results show that low carbon (less than 100 ppM) must be maintained to achieve predictable recovery and uniform distribution of titanium (target ± 0.1 wt percent). (auth)

**28509** (NMI-7012) FINE-GRAINED URANIUM BY THE ROTATING ELECTRODE SHOT PROCESS. Jordan, E. F. (Nuclear Metals, Inc., Concord, Mass. (USA)). 19 Nov 1962. 28p. Dep. NTIS $4.50.

Declassified 27 June 1975.

Particulate uranium with unusual grain structure is produced by the rotating electrode shot process (arc melting a rapidly rotating electrode) when the molten droplets are allowed to impinge on a cooled surface. The solidified product, designated as "splat," contains grains with a diameter below 10 microns and an unresolved acicular structure. When consolidated by extrusion, splat has very fine grains; the extruded splat resembles cast and wrought uranium in other respects. (auth)

**28510** (SAND-75-8710) ELECTROCHEMICAL JOINING: PROCESS, APPLICATIONS, AND PROPERTY DATA. Dini, J. W.; Johnson, H. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). Aug 1975. Contract AT(29-1)-789. 20p. (CONF-751012-4). Dep. NTIS $4.00.

From SME/ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

A procedure for joining various materials by using electroplating is described. Parts to be joined are first given a specific taper. Then they are cleaned, mated, and the triangular segment between the tapered edges is built up by electroplating, and the joint machined to final tolerance. For some parts, the taper is not needed. Since the joining process is done at room temperature, the shrinkage and distortion problems associated with high temperature joining methods are eliminated. Materials that have been electrojoined include aluminum, beryllium, copper, stainless steels, steels, titanium, and uranium and some of its alloys. Various tests such as tensile, compressive, heating, and corrosion have shown electrochemical joining to be a useful alternative to conventional processes. Platings which have been used as "joint fillers" include nickel, copper, and nickel-cobalt alloy. Laboratory demonstrations of this process will include the joining of 6061-T6 aluminum to 304 stainless steel by use of copper plating. (auth)

**28511** (UCRL-77253) ELECTRON BEAM WELDING FUNDAMENTALS AND APPLICATIONS. Mara, G. L.; Armstrong, R. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1975. 10p. (CONF-751012-2). Dep. NTIS $4.00.

From SME/ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

The electron beam welding process is described and the unique mode of operation and penetration explained by a description of the forces operating within the weld pool. This penetration model is demonstrated by high speed cinematography of the weld pool on several materials. The conditions under which weld defects are formed are discussed and examples are presented. (auth)

**28512** (UCRL-77254) NARROW GROOVE GAS METAL-ARC WELDING OF ALUMINUM. Armstrong, R. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1975. 12p. (CONF-751012-3). Dep. NTIS $4.00.

From SME/ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

The Gas Metal-Arc (GMA) welding process is explained and the equipment used described with an analysis of power supply function and the action of the arc, followed by discussion of general applications and problems. GMA braze welding of beryllium is then described, as is the development of a special high purity filler wire and a narrow deep groove joint design for improved weld strength in beryllium. This joint design and the special wire are applied in making high strength welds in high strength aluminum for special applications. High speed motion pictures of the welding operation are shown to illustrate the talk. (auth)

**28513** (WCAP-8324-A) CONTROL OF DELTA FERRITE IN AUSTENITIC STAINLESS STEEL WELDMENTS. Enrietto, J. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Jun 1975. 42p. Westinghouse Electric Corp., Pittsburgh.

The role of delta ferrite in mitigating hot-cracking in stainless steel (ss) welds is discussed. It is hypothesized that if an undiluted weld deposit contains a given delta ferrite as determined by a Schaeffler diagram, all other ss weldments made using the same welding parameters and the same heat of weld metal should have a similar delta ferrite content. Preliminary data are presented that confirm the hypothesis, and future programs are described for further testing of the hypothesis. (DLC)

**28514** SURFACING WITH STAINLESS STEEL: STRIP ELECTRODES. Bernstein, A.; Backman, A.; Areskoug, M.; Forsberg, S. (Sandvik AB, Sandviken, Sweden). Weld. J. (N. Y.); 54: No. 9, 647-655(Sep 1975).

From 56th AWS annual meeting; Cleveland, OH (21 Apr 1975).

Surfacing, a welding process used to deposit a layer of metal on a surface, is used to clad low alloy steel pressure vessels with stainless steel. Process variables, selection of consumables, deposit characteristics, and future development are discussed. (DLC)

**28515** REGULARITIES OF REFRACTORY ELECTRODE-TOOLS WEARING IN ELECTROMECHANICAL TREATMENT. Samsonov, G. V.; Paustovskii, A. V. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 82-86(May 1975). (In Russian).

Regularities are studied for the process of contact phenomena in electromechanical treatment of zirconium, niobium, and molybdenum with titanium, niobium, tungsten carbides, and titanium diboride. The determined regularities are explained from the position of the model of configuration localization. (auth)

**28516** STUDY OF THE LOW-TEMPERATURE METHOD FOR PRODUCTION OF CADMIUM BRONZE. Kornienko, V. P.; Kolesnikov, V. N.; Dubrovskaya, M. N.; Karpenko, V. V. (Kharkov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 1-5 (May 1975). (In Russian).

A method is suggested for production of cadmium bronze sintered articles. It is based on combination of the low-temperature chemical method of cadmium bronze powder production with low-temperature hot pressing. The latter provides for an ideal distribution of cadmium in the alloy owing to formation of an intermediate salt solid solution, the fine-grained structure of the material with an increased mechanical properties, and also decreases cadmium losses to 2 to 5% depending on conditions of hot pressing. (auth)

**28517** ENERGY CONSUMPTION IN SMITH FORGING, OF METAL REINFORCED COMPOSITION. Karpinos, D. M.; Tuchinskii, L. I.; Vishnyakov, L. R.; Fefer, V. Ya. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 20-26(Jun 1975). (In Russian).

Results are presented of an experimental study of energy consumption in obtaining unidirectional reinforced materials: the alloy XH60B-tungsten wire and titanium-molybdenum wire. The dependences are established of the reduced work of compaction on the pitch of fiber arrangement and the thickness of matrix layers. Energy consumption is satisfactorily described by the suggested analytical dependence. A less degree of settling is needed for providing adhesion between the matrix layers in the reinforced material than for the adhesion between the layers of nonreinforced stratified material. This is connected with the additional deformation of matrix plates due to the extrusion of the matrix metal into the interspaces between the fibers in the process of composition compacting during Smith forging. (auth)

**28518** EFFECT OF IRON FAMILY METALS ON NIOBIUM SINTERING. Samsonov, G. V.; Yakovlev, V. I. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 54-58(Jun 1975). (In Russian).

The effect of small additives (0.05 to 1.0 wt.%) of the iron family metals (Fe, Co, Ni) is studied as applied to the process of sintering within a temperature range of 1000 to 2000°C and the properties of sintered niobium. Fe, Co, Ni additives activate the process of sintering due to localization of the niobium atom free electrons in 3d-states, which results in a decrease of the margin of free energy of the system niobium-added metal. Nickel as the metal characterized by the highest acceptor ability produces the best activating effect. (auth)

**28519** USE OF MARAGING STEELS FOR PARTS OF METAL WORKING MACHINES. Leibova, N. M.; Zot'eva, A. S.; Kagan, E. S.; Felikson, A. E. Met. Sci. Heat Treat.; 16: No. 9-10, 852-855(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 35-39(Oct 1974).

During prolonged aging of maraging steel 03Kh11N10M2T, the dimensions change considerably. The wear resistance is low after aging but can be increased by nitriding. Two hardening heat treatments are recommended for critical machine parts: a) nitriding combined with aging at 540° for parts such as guides; b) preliminary tempering at 580°, followed by grinding and nitriding at 540°, for parts such as hypoid indexing gears. Aging combined with nitriding at 540° and holding for 36 h reduces the linear dimensions by 1.2 $\mu$/mm, and preliminary tempering at 580° for 3-5 h makes it possible to reduce this value to 0.4 $\mu$/mm. (auth)

**28520** PHASE TRANSFORMATIONS AND PROPERTIES OF NEW DIE STEEL 4Kh4M1V3F. Madyanov, S. A.; Voronenko, B. I.; Makhnev, E. S.; Bannova, M. I. (Gorky Research Physicotechnical Inst., USSR). Met. Sci. Heat Treat.; 16: No. 9-10, 744-745(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 19-21(Sep 1974).

The impact toughness of steel 4Kh4M1V3F (4.1% Cr, 1.25% Mo, 2.0% W) can be improved by increasing the cooling rate during quenching, which prevents the bainitic transformation and precipitation of carbide phase during cooling. (auth)

**28521** FORMATION AND PROPERTIES OF NITRIDE CASE ON IRON-TUNGSTEN ALLOYS. Belotskii, A. V.; Nikitina, O. V. (Kiev Polytechnical Inst.). Met. Sci. Heat Treat.; 16: No. 9-10, 821-822(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 6-7(Oct 1974).

In the process of nitriding at 500-590° the $\gamma'$-phase is alloyed with tungsten (1.4 to 8.9% W) and the solubility of nitrogen in ferrite increases. The microhardness of the case also increases. The combination of high-temperature nitriding with subsequent quenching makes it possible to obtain a case with a fairly high hardness. (auth)

**28522** LOW-TEMPERATURE CARBONITRIDING OF STEEL COMBINED WITH QUENCHING OF THE SURFACE LAYER. Lakhtin, Yu. M.; Neustroev, G. N.; Botov, V. M. (Moscow Highway Inst.). Met. Sci. Heat Treat.; 16: No. 9-10, 823-826(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 8-11(Oct 1974).

A new process of combined low-temperature carbonitriding with quenching of the surface layer was developed to improve the wear resistance of machine parts made of Armco iron, 20Kh, 40Kh, and 38KhMYuA steels. Carbonitriding is conducted at 690-700°. In the first 2-3 h, the surface of the steel is austenitized in a mixture of 5-10% $NH_3$ + 90-95% $N_2$ for carbon and low-alloy steels and in 30% $NH_3$ + 70% $N_2$ for high-alloy steels. In the following 2-5 h, carbonitriding occurs at the same temperature in an atmosphere of carburizing gases and ammonia, followed by quenching in oil. After this new treatment of steels 20Kh, a diffusion layer 0.4-0.7 mm thick is formed which consists of a carbonitride zone 10-20 $\mu$ thick at the surface, a martensite zone with HV 700-800 to a depth of 0.08-0.12 mm, and a transition zone 0.25-0.5 mm deep. (auth)

**28523** OXIDATION-FREE GRANULATION OF METALS. Glazunov, S. G.; Solonina, O. P.; Chereshneva, I. F. Met. Sci. Heat Treat.; 16: No. 9-10, 765-768(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 41-44(Sep 1974).

It is possible to obtain high-quality spherical granules from different alloys with different densities (Ti, Mo, Ni, steels). The strength characteristics at room and elevated temperatures increase considerably as the result of granulation. A relationship was found between the granulometric composition and the physical properties of alloys and the parameters of the melting process. Preliminary analysis of the microstructure of granules of different alloys indicates a fine dendritic structure and the absence of large precipitates of second phase. The granules obtained by the given method are promising original materials for producing semifinished products with excellent properties, composite materials, and porous parts such as filters. (auth)

**28524** SENSITIVITY OF DIE STEEL 4Kh4VMFS TO THE COOLING RATE DURING QUENCHING. Tishaev, S. I.; Poznyak, L. A. (Ukrainian Scientific-Research Inst. of Special Steels, Alloys, and Ferroalloys, Kharkov). Met. Sci. Heat Treat.; 16: No. 9-10, 740-743(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 16-19(Sep 1974).

For the secondary-hardening steel 4Kh4VMFS (0.88 W, 1.2 Mo, 0.76 V), a slow cooling rate after austenitizing is most dangerous at 750-800° (above $Ar_3$) and 300-350° (intermediate range). Alloying of steel 4Kh4VMFS with 1.5-2% Ni increases the hardenability and ensures high toughness (3.5-4 kg-m/cm$^2$ at 25° and 5.0-6.0 kg-m/cm$^2$ at 600°) in forgings up to 500 × 500 mm in section. However, the heat resistance of the steel decreases in this case. Manganese in amounts of 1-1.5% has no effect on the decomposition rate of supercooled austenite in steel 4Kh4VMFS in the supercritical or intermediate ranges. (auth)

**28525** METHOD AND EQUIPMENT FOR PRODUCTION OF PARTICLES, e.g., NUCLEAR FUEL PARTICLES. Simpson, M. P.; Stockwell, C. L. (to UKAEA London Office). German (FRG) Patent 2,436,485/A/. 20 Feb 1975. 15p. (In German).

The invention relates to the production of uniform spherical particles and is utilized in the production of fuel particles. A liquid initial material containing, e.g., an uranium alloy, is formed into droplets by means of a special droplet formation unit consisting of a spinning jet or a jet nozzle which is set vibrating by a vibrator. The resulting droplet stream is carried across an electrode (round or flat) with a different electric potential. Here the droplets receive an electric charge of the same sign to preserve their spherical shape. The droplets are carried into reagents, e.g., ammonia gas or ammonium hydroxide, and transformed into gel particles. (GE)

**28526** ELECTRODEPOSITION OF A CADMIUM–NICKEL ALLOY FROM POLYETHYLENEPOLYAMINE ELECTROLYTES. Soboleva, L. I.; Kudryavtsev, N. T.; Tsupak, T. E.; Lukashova, L. S. (Moscow Chemicotechnological Inst.). Prot. Met. (USSR) (Engl. Transl.); 10: No. 6, 637-639(1974).

Translated from Zashch. Metal.; 10; No. 6, 702-705(1974).

An investigation was made of a polyethylenepolyamine electrolyte, favorably distinguished from other electrolytes. A good quality cadmium–nickel alloy was obtained from it in a broad range of current densities. (auth)

## *Properties, Structure, and Phase Studies*

*Refer also to abstracts 27653, 27903, 29620, 30130, 30167, 30172, 30202, 30305, 30370, 30375, and 30403.*

**28527** (AECL-5101) LITERATURE SEARCH ON SOME PROPERTIES OF ZIRCALOY-4 AT HIGH TEMPERATURES. Petersen, C. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Mar 1973. Translation by R. Gerarts and L. G. Bell of KFK-Ext 6/73-6. 44p. Dep. NTIS (US Sales Only) $5.25. AECL.

Mechanical and physical properties of Zircaloy-4 are compiled for the temperature interval of 600 to 1800°C. The behavior of stress-strain, ultimate strength, and ductility under internal pressure, thermal expansion, thermal conductivity, and total emissivity are described. (auth)

**28528** (BNL-20306) IMPROVEMENTS IN THE CRITICAL CURRENT DENSITIES OF $Nb_3Sn$ BY SOLID SOLUTION ADDITIONS OF Sn IN Nb. Luhman, T.; Suenaga, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 17p. (CONF-750716-9). Dep. NTIS $4.00.

From international cryogenic materials conference; Kingston, Ontario, Canada (22 Jul 1975).

The effectiveness of solid solution additions of Sn to Nb in improving the superconducting properties of diffusion processed $Nb_3Sn$ conductors was examined. It was found that an increase in the superconducting critical current density, Jc, as function of layer thickness (d) may be obtained for thick $Nb_3Sn$ layers by solid solution additions of Sn in Nb. A large increase in J/sub c/(d) is also achieved by increasing the Sn content in the bronze matrix material. In addition to uses of this material in magnet fabrications a potential application of these improved J/sub c/(d) values may lie in the use of $Nb_3Sn$ in power transmission lines. Here, a high superconducting critical current density is necessary throughout the material to carry the increased current during fault conditions. The magnetic field dependence of J/sub c/ is a function of alloy content but the alloying changes studied here do not increase the high field critical current capability of $Nb_3Sn$. (auth)

**28529** (BNL-20403) SUPERCONDUCTING MATERIALS FOR LARGE SCALE APPLICATIONS. Dew-Hughes, D. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 25p. (CONF-750716-11). Dep. NTIS $4.25.

From International cryogenic materials conference; Kingston, Ontario, Canada (22 Jul 1975).

Applications of superconductors capable of carrying large current densities in large-scale electrical devices are examined. Discussions are included on critical current density, superconducting materials available, and future prospects for improved superconducting materials. (JRD)

**28530** (BNWL-SA-5327) INTERNAL STRESSES IN ALPHA-PLUTONIUM DURING DEFORMATION. Merz, M. D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract AT(45-1)-1830. 7p. (CONF-750915-20). Dep. NTIS $4.00.

From 5th international conference on plutonium and other actinides; Baden-Baden, F. R. Germany (10 Sep 1975).

Internal stresses were measured in fine-grained (2 mu m) and coarse-grained (20 mu m) alpha-plutonium. A stress drop technique (strain transient dip test) was used and the measurements were made for applied creep stresses, sigma/sub a/, from 45 MPa (6250 psi) to 207 MPa (30000 psi) and temperatures from 60 to 113°C. The internal stress sigma/sub i/ varied from 17 to 84 MPa and had a weak dependence on applied stress. The effective stress, given by sigma/sub e/ equals sigma/sub a/-sigma/sub i/, which is associated with the stress to move dislocations, increased nearly one to one with applied stress, especially at high stresses. The strain rate obeyed the relation epsilon equals K(T)sigma/sub e//sup n/ where K(T) is a temperature-dependent term given approximately by Kexp (–104 KJ/mol/RT) and n approximately equal to 3. In fine-grained alpha-plutonium, the internal stress was interpreted as the stress driving recovery processes near grain boundaries. Measurements of internal stress in alpha-plutonium with 20-mu m grain size indicated a much higher internal stress than for the 2-mu m grain size. (5 fig) (auth)

**28531** (CEA-R-4653) CONTRIBUTION TO THE DETERMINATION OF APPLICATION LIMITS FOR AN INDUSTRIAL UMo 10 ALLOY. Influence of Metallurgical and Mechanical Factors. Girardin, J. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92—Montrouge (France)). Sep 1975. 72p. (In French). Dep. NTIS (US Sales Only) $6.75.

Thesis.

A critical review of uranium alloys suitable for mechanical use has led to the choice of the nonoxidisable UMo 10 alloy in a metallurgical state corresponding to a cast part. Characteristics of this state (relaxation of the metastable γ phase at 400°C for 5 h, followed by cooling at 0.5°C/mn) were determined chiefly by micrography and Castaing microprobe analyses. Mechanical resistance was then tested under static and dynamic stresses by bending and twisting at different frequencies, carried out mainly on the alloy of mean carbon content 125 × $10^{-6}$ in laboratory air and in a damp atmosphere at room temperature. Many scanning electron microscope examinations were performed for the purpose of establishing a fractographic chart. Results confirm the good mechanical properties of the industrial alloy chosen but show that its sensitivity to corrosion under tension in air and to fatigue-corrosion, especially at low frequencies, limit its application. Finally the modified Goodman-Smith diagram was plotted under bending stress for the two frequencies 20 and 5 Hz. (auth)

**28532** (EURFNR-1232) INFLUENCE OF THE PRELIMINARY TREATMENT CONDITION ON THE LONG-TERM PROPERTIES AND CREEP BEHAVIOR OF THE STEEL X8CrNiMoVNb 1613. Schirra, M. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Oct 1974. Translation of KFK-2040. 65p. Dep. NTIS $5.45.

Results of experiments on mechanical properties of non-irradiated samples of Cr–Mn–Ni–Mo steel are presented. Information is included on tensile properties, creep, fracture

properties, segregation behavior, and effects of processing. (JRD)

**28533** (LA-UR-75-1818) ELECTRON CONFIGURATIONS AND BONDING IN THE EARLY ACTINIDE METALS. Hill, H. H.; Kmetko, E. A. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 12p. (CONF-750915-12). Dep. NTIS $4.00.

From 5th international conference on plutonium and other actinides; Baden-Baden, F.R. Germany (10 Sep 1975).

The charge density in sodium metal was demonstrated to consist of well-defined 3s and 3p portions each of which resembles that found in the corresponding free atom. Some examples of agreement between the molecular orbital based energy band picture and the Engel–Brewer (E-B) theory are discussed. Reasons for differences between the nonintegral configurations of the former with the integral atomic-like ones of the latter are given. The main point of disagreement between the energy band approach and the E-B theory lies in the matter of configuration assignments for the various crystal structures. In the case of iron, the calculated valence charge hybridization for the bcc and fcc structures is hardly any different though the E-B theory assigns the configurations s and $sp^2$ to these modifications, respectively. A step was taken toward establishing realistic configurations for the early actinide metals. Relativistic, self-consistent band calculations, from which the spin–orbit splitting was omitted, yield results which agree with nonrelativistic calculations. Furthermore, a surprising amount of s, d and f hybridization occurs in the 6p core band, to the extent of almost a half an electron per atom. The f-like charge in this band is completely delocalized, however. The disagreement between the f electron assignments of Zachariasen and others, based upon the variation of metallic radius with atomic number in the actinide metals, can be understood on the basis of the delocalization of the f-like charge which occurs in the lower reaches of the valence energy bands. (DLC)

**28534** (N-75-12127) HARDNESS BEHAVIOR OF BINARY AND TERNARY NIOBIUM ALLOYS AT 77 AND 300$^0$K. Stephens, J. R.; Witzke, W. R. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Dec 1974. 16p. (NASA-TN-D-7847; E-8083). NTIS $3.25.

Effects of alloy additions of zirconium, hafnium, molybdenum, tungsten, rhenium, ruthenium, osmium, rhodium, and iridium on the hardness of niobium was determined. Both binary and ternary alloys were investigated by means of hardness tests at 77 and 300$^0$K. Results showed that atomic size misfit plays a dominant role in controlling hardness of binary niobium alloys. Alloy softening, which occurred at dilute solute additions, is most likely due to an extrinsic mechanism involving interaction between solute elements and interstitial impurities. (auth)

**28535** (N-75-13086) PROCESS DEVELOPMENT OF TWO HIGH STRENGTH TANTALUM BASE ALLOYS (ASTAR-1211C AND ASTAR-1511C). Final Report, June 1969–February 1972. Ammon, R. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1974. 310p. (NASA-CR-134606; WANL-M-FR-74-002). NTIS $9.25.

Two tantalum base alloys, Ta–12W–1.0Re–0.7Hf–0.025C (ASTAR-1211C) and Ta–15W–1.0Re–0.7Hf–0.025C (ASTAR-1511C), were cast as 12.5 cm (5 inch) diameter ingots and processed to swaged rod, sheet, forged plate, and tubing. Swaged rod was evaluated with respect to low temperature ductility, elevated temperature tensile properties, and elevated temperature creep behavior. A standard swaging process and final annealing schedule were determined. Elevated temperature tensile properties, low temperature impact properties, low temperature DBTT behavior, and extended elevated temperature creep properties were determined. A process for producing ASTAR-1211C and ASTAR-1511C sheet were developed. The DBTT properties of GTA and EB weld sheet given post-weld anneal and thermal aging treatments were determined using bend and tensile specimens. High and low temperature mechanical properties of forging ASTAR-1211C and ASTAR-1511C plate were determined as well as elevated temperature creep properties. Attempts to produce ASTAR-1211C tubing were partially successful while attempts to make ASTAR-1511C tubing were completely unsuccessful. (auth)

**28536** (ORNL-SUB-3599-4) MULTIAXIAL CREEP BEHAVIOR OF 304 STAINLESS STEEL. Findley, W. N.; Mark, R. (Brown Univ., Providence, R. I. (USA)). Jul 1975. 47p. (EMRL-63). Dep. NTIS $5.50.

Tests in combined tension-torsion, pure tension and pure torsion, were conducted at elevated temperature (about 1100$^0$F). Most of these tests were repeats of previous experiments where friction in the extensometer caused anomalous creep behavior. The existence of a creep surface at 12.5 ksi effective Mises stress was explored. Work on a compression creep apparatus continued. Creep and recovery data were fitted to the equation epsilon/sub ij/ equals epsilon$^0$/sub ij/ + epsilon$^+$/sub ij/t/sup n//sub ij/ by means of a least squares method. (5 tables, 10 fig) (auth)

**28537** (ORNL-TM-4954) NICROSIL II AND NISIL THERMOCOUPLE ALLOYS: PHYSICAL PROPERTIES AND BEHAVIOR DURING THERMAL CYCLING TO 1200 K. Moore, J. P.; Graves, R. S.; Herskovitz, M. B.; Carr, K. R.; Vandermeer, R. A. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 33p. AT.

The thermal conductivities, electrical resistivities, and Seebeck coefficients of a Nisil type alloy (Ni + 4.3 percent Si + 0.1 percent Mg) and a Nicrosil II type alloy (Ni + 15.5 percent Cr + 1.5 percent Si) were measured from 80 to 400$^0$K and mean coefficients of thermal expansion of both materials were measured from 400 to 1100$^0$K. The Nisil type material had a much higher thermal conductivity than the Nicrosil II type and the first three properties of the Nisil type alloy were affected by the ferromagnetic-paramagnetic transition which occurs near room temperature. Thermoelement breakage occurred during thermal cycling to 1200$^0$K of 304 stainless steel sheathed, MgO insulated, grounded hot junction, Nicrosil II versus Nisil thermocouple assemblies and was caused by a combination of effects. These effects included different thermal expansion coefficients of thermocouple wire and 304 stainless steel sheath, large grains within the Nisil wire which decreased the wire ductility and, possibly, low density of the MgO thermocouple insulation. Breakage problems are similar to those reported previously for other nickel base alloy thermocouples. (auth)

**28538** (RFP-2379) FABRICATION AND PROPERTIES OF A SEXINARY URANIUM-BASE ALLOY. Jackson, R. J.; Boland, J. F.; Bloore, E. W. (Atomics International Div., Golden, Colo. (USA)). 25 Aug 1975. Contract E(29-2)-3533. 22p. Dep. NTIS $4.00.

A sexinary uranium-base alloy, containing molybdenum, niobium, zirconium, titanium, and vanadium, was evaluated from a fabrication and properties standpoint. The alloy had the following composition: uranium (97.10-weight percent), 0.75-wt percent molybdenum, 0.75-wt percent niobium, 0.75-wt percent zirconium, 0.50-wt percent titanium, and 0.15-wt percent vanadium; or uranium (91.58-atomic percent), 1.76-at. percent molybdenum, 1.81-at. percent niobium, 1.85-at. percent zirconium, 2.34-at. percent titanium, and 0.66-at. percent vanadium. The alloy has a high density (18.1 grams per cubic centimeter) and a superior corrosion resistance compared with unalloyed uranium. Studies related to fabrication include melting and casting, homogeneity, chemistry, extrusion (K equals 5 tons per inches$^2$ at 975$^0$C) (K equals 69 megapascals), and machining. The alloy was heat-treatable to a wide variety of mechanical properties by solution quenching followed by treatments to underage or overage the material. Studies related to properties include tensile properties, hardness and hardenability, transformation structures, fracture appearance, and metallography. (auth)

**28539** (UCRL-77291) DYNAMIC TEAR TEST AND ITS POTENTIAL FOR EVALUATING THE TOUGHNESS OF WELDS. Mara, G. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1975. 7p. (CONF-751012-5). Dep. NTIS $4.00.

From SME/ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

The Dynamic Tear (DT) test is used to evaluate the influence of electron beam welding on the mechanical properties of HP-9-4-20 and 250 maraging steel. Basic trade-offs in strength and toughness are identified thereby revealing the usefulness and degree of sensitivity of the test. (auth)

**28540** (UCRL-77369) COMPUTER SIMULATION OF INTERSTITIAL DIFFUSION IN TUNGSTEN. Guinan, M. W.; Stuart, R. N.; Borg, R. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Oct 1975. 9p. (CONF-751006-5). Dep. NTIS $4.00.

From international conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

A fully dynamic computer model employing approximately 1500 atoms interacting through an empirical pair potential is used to follow the diffusion of a self-interstitial atom in tungsten. The dynamics of the jump process have been fully explored over a wide range of temperature. The results show that dynamic calculations must be run for times long enough to establish diffusion coefficients from macroscopic motion of the defect since methods based on discrete jump counting can lead to serious error. (auth)

**28541** (Y-1995) CHARACTERIZATION OF URANIUM-1 AND 2 WEIGHT PERCENT ZIRCONIUM ALLOYS. Hemperly,

V. C. (Oak Ridge Y-12 Plant, Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 14p. Dep. NTIS $4.00.

A preparation method for wrought uranium-1 and 2 wt percent zirconium alloys was developed. Tensile tests of the 2 wt percent zirconium alloy demonstrate that it can be solution treated, water quenched, and age hardened to obtain high strength with good ductility; hardening response of the 1 wt percent zirconium is much smaller. A metallographic study shows that the alloys on lower-level aging respond in a manner somewhat similar to the uranium-titanium alloys at comparable atomic percentage compositions. (auth)

**28542** THERMOPOWER OF DILUTE ALLOYS OF INDIUM. Dudenhoeffer, A. W. Norman, OK; University of Oklahoma (1974). 130p. University Microfilms Order No. 75-6511.

Thesis (Ph. D.).

An experimental investigation of a new theory of electron-diffusion thermopower is discussed. A figure of merit for this "Nielsen-Taylor" theory in various metals is established, and it indicates that the effect should be largest in lead, indium, thallium, and aluminum, in that order. Previous investigations have been carried out for lead and aluminum. The thermopower of indium (or any metal) changes when impurity scattering centers are introduced into it. This change in the thermopower as a function of temperature is analyzed in terms of the Nielsen-Taylor theory and in terms of the competing process known as "phonon drag." Definite conclusions as to the validity of the new theory are hampered by the complex nature of this phonon drag, but the experimental data is consistent with the Nielsen-Taylor theory. (Diss. Abstr. Int., B)

**28543** SUPERCONDUCTIVE TUNNELING IN MOLYBDENUM. Pak, Y. L. Cleveland; Case Western Reserve University (1974). 128p. University Microfilms Order No. 75-5075.

Thesis (Ph. D.).

The technique of electron tunneling through a Schottky barrier which is created by a pointed single crystal of degenerate gallium arsenide in mechanical contact with a bulk molybdenum sample was used to obtain the superconducting energy gap and its temperature dependence for pure molybdenum. Some indication of phonon spectrum for molybdenum as well as gallium arsenide was observed from the tunneling characteristics. The transition temperatures of molybdenum and its very dilute alloys with iron concentrations up to 80 ppM were measured. There is no measurable superconducting energy gap for alloys with 27.5 ppM or more of iron in molybdenum while the transition temperature is nonzero. All these measurements were carried out in a $^3He$-$^4He$ dilution refrigerator which can reach to a temperature down to the millikelvin range. The spin-flip lifetimes of electrons due to magnetic impurities in alloys are calculated from both superconducting transition temperature results and resistivity measurements. A large zero-bias anomaly has been observed in the gallium arsenide/molybdenum junctions. The anomaly corresponds to a resistance peak centered at zero bias. The junction resistance at zero-bias is a strong function of temperature. When the temperature was lowered below the transition temperature of molybdenum, the superconducting energy gap of molybdenum was observed, which indicated that the mechanism of current flow is by electron tunneling. (Diss. Abstr. Int., B)

**28544** STUDY ON TANTALUM GETTER SORPTION IN THE GASEOUS ATMOSPHERE OF TECHNICAL NITROGEN. Chocianowski, P. Elektronika; 16: No. 5, 205(1975). (In Polish).

The results of the study show that tantalum as a getter has a maximum technical $N_2$ sorption at ca 1050°C. (auth)

**28545** NUCLEAR MAGNETIC RESONANCE IN A SERIES OF SUPERCONDUCTING $V_{1-x}Pt_x$ COMPOUNDS. Wulffers, L. A. G. M.; Poulis, N. J. (Rijksuniversiteit Leiden (Netherlands). Kamerlingh Onnes Lab.). pp 353 of Magnetic Resonance and Related Phenomena. Vol. II. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th Ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

Measurements of the Knight-shift of $^{51}V$ and $^{195}Pt$ in a series of $V_{1-x}Pt_x$ compounds show that the $N(E_F)$ depends on the concentration x of the Pt. This agrees with the observed behavior of the $T_c$ as a function of the concentration. (auth)

**28546** NMR STUDY OF $La_3X_{1-y}X'_y$ AND $La_3XC$ TERNARY ALLOYS (X = Al, Ga, In, Tl, Sn, Pb). Descouts, P.; Perrin, B.; Dupanloup, A. (Geneva Univ. (Switzerland)). pp 335-336 of Magnetic Resonance and Related Phenomena. Vol. II. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th Ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

In $La_3X_{1-y}X'_y$ the Knight-shift of $^{115}In$ and $^{205}Tl$ is strongly temperature and composition dependent and the super conducting properties are very close to those of corresponding binary compounds. In the $La_3XC$ perovskite carbides the X-site Knight-shift is temperature independent and the electronic specific heat coefficient and super conducting temperature $T_c$ are strongly reduced. (auth)

**28547** ELECTRON SPIN RESONANCE AND SUSCEPTIBILITY IN THE SUPERCONDUCTOR $La_xCe_{1-x}Ru_2$. Engel, U.; Baberschke, K.; Koopmann, G. (Freie Univ. Berlin (F. R. Germany). Fachbereich Physik). pp 311-312 of Magnetic Resonance and Related Phenomena. Vol. II. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The ESR of $Gd^{3+}$ in the solid solution $La_xCe_{1-x}Ru_2$ ($0 < x < 1$) has been measured. The change of the negative g-shift and the thermal broadening of the line-width with respect to x is attributed to a shift of a narrow d-band of the conduction-electrons at the Fermi surface. (auth)

**28548** INVESTIGATION OF LATTICE DEFECTS BY REACTOR PHYSICAL METHODS. de Waard, H. (Rijksuniversiteit Groningen (Netherlands)). Ned. Tijdschr. Natuurkd.; 41: No. 8, 89-96 (19 Apr 1975). (In Dutch).

34 refs.

Lattice defect investigations are reviewed using various techniques, including the Mössbauer effect (energies less than 100 keV), perturbed angular correlations with gamma spectra, low temperature nuclear spin orientations, disorientation studies using nuclear magnetic resonance. Detailed results are given for implantations of atoms with electrons in the 5(S, p) shield in iron and nickel. Typical Mössbauer spectrographs are illustrated. A section is included on implantations in semiconductors, especially Sn, Sb, and Te isotopes used for doping diamond, silicon and germanium bases. A review of relative aspects is given based on the June 1974 Uppsala conference on Hyperfine Interactions. (NL)

**28549** SPIN-PLASMA RELAXATION IN SOLIDS. Deigen, M. F.; Suslin, L. A. (AN Ukrainskoj SSR, Kiev). pp 9-12 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The relaxation mechanism of paramagnetic centers generated by interaction between those centers and current carrier charge density fluctuations in crystals is investigated. The theory developed includes plasmons the same as individual movements of current carriers. The indirect coupling between paramagnetic centers via plasmon field and magnetic levels shift of center caused by this field is investigated. (auth)

**28550** MOESSBAUER STUDIES OF MAGNETIC RARE EARTH INTERMETALLICS: ELECTRONIC RE-ARRANGEMENT EFFECTS IN SOURCE EXPERIMENTS. Hirst, L. L. (Frankfurt Univ. (F. R. Germany). Inst. fuer Theoretische Physik); Stoehr, J.; Zech, E.; Kalvius, G. M. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.); Shenoy, G. K. (Centre National de la Recherche Scientifique, 67 - Strasbourg (France). Lab. de Chimie Nucleaire). pp 67-68 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

Mössbauer (MB) source experiments of magnetically ordered rare earth (RE) intermetallics often show deviations from the hyperfine (hf) structure, which is expected from the thermally populated electronic levels. This is discussed in terms of slow re-arrangement of the populations of electronic energy levels after $\beta^+$ decay. (auth)

**28551** MOESSBAUER EFFECT INVESTIGATION IN SOME PSEUDOBINARY IRON LAVES PHASES. Burzo, E.; Bodea, M.; Barb, D. (Institutul de Fizica Atomica, Bucharest (Romania)). pp 71-72 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The x dependence of the $^{57}Fe$ hyperfine fields and isomer shifts in $Dy(Fe_xNi_{1-x})^2$ compounds is discussed. The thermal variation of the hyperfine field is also presented. The Mössbauer effect data are correlated with the structural and magnetic measurements. (auth)

**28552** $^{151}Gd$ 86.5 keV MOESSBAUER EXPERIMENTS ON SINGLE CRYSTAL Gd IN FIELDS UP TO 6T. Bowden, G. J.; Ross, J. W.; McEwen, K. A. (Manchester Univ. (UK)). pp 77-78

of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

Mössbauer experiments on a single crystal slice of Gd metal were used to determine (i) the nuclear ratios $g_e/g_g$ (1.203 ± .017) and $Q_e/Q_g$ (0.35 ± .06) (ii) the magnetic hyperfine field $H_{eff}$(−38.2 ± 1T) and (iii) the electric field gradient $V_{cc}$ (3.55 ± .08 k $Vnm^{-2}$). (auth)

**28553** NMR STUDY OF PINNED DOMAIN WALLS IN FERROMAGNETIC DYSPROSIUM METAL. Barak, J.: Berthier, Y. (Grenoble-1 Univ., 38 (France)). pp 83-84 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. A. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The influence of annealing on the NMR of $Dy^{163}$ in ferromagnetic Dy metal is studied. The depinning of the wall changes the rf field enhancement factor from $10^3$ to $10^4$ and enables observation of $T_2$ due to Suhl-Nakamura interaction beside $T_2$ of Walstdt mechanism. (auth)

**28554** SPIN RE-ORIENTATION IN $HoFe_3$ AT 85K. Arif, S. K.; Bowden, G. J.; Bunbury, D. St. P. (Manchester Univ. (UK)). pp 85-86 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The Mössbauer effect in $^{57}Fe$ was used to identify and follow a temperature dependent spin re-orientation in the ferrimagnetic compound $HoFe_3$. It is surmised that the change in the direction of easy magnetization is due to competition between rare earth ions at two non-equivalent crystal sites. (auth)

**28555** MOESSBAUER STUDIES OF $REIr_2$ INTERMETALLIC COMPOUNDS. Tanner, G.; Wagner, F. E.; Kalvius, G. M. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.); Shenoy, G. K. (Centre National de la Recherche Scientifique, 67- Strasbourg (France). Lab. de Chimie Nucleaire); Buschow, K. H. J. (Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands)). pp 87-88 of Magnetic Resonance and Rel lated Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The magnetic structure of the cubic Laves phase $REIr_2$ (RE = La, Ce, Pr, Nd, Gd, Tb, Dy, Ho, Yb) compounds has been studied by means of the Moessbauer absorption of the 73 keV gamma rays of $^{193}Ir$. (auth)

**28556** ELECTRIC FIELD GRADIENTS IN ALLOYS OF HEAVY RARE EARTH METALS. Holden, E. M.: Mackenzie, I. S.; McCausland, M. A. H. (Manchester Univ. (UK)). pp 113-114 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

NMR measurements were made on $^{165}Ho$ in ferromagnetic alloys with Gd, Tb, and Tm. Variations of the electric quadrupole splitting with lattice parameters and with the orientation of the magnetization are used to estimate the electric field gradient due to conduction electrons. (auth)

**28557** EPR STUDY OF $Gd_xY_{1-x}Cu$ COMPOUNDS. Burzo, E.; Baican, R. (Institutul de Fizica Atomica, Bucharest (Rumania)). pp 151-152 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

EPR investigations of $(Gd_xY_{1-x})Cu$ compounds in the concentration range x = 1.0 to x = 0.001 are presented. The results are analyzed in a two band model which considers the relaxation of Gd spin to s and d-band conduction electrons. The magnetic interactions in compounds are estimated. (auth)

**28558** NUCLEAR MAGNETIC RESONANCE IN DILUTE ALLOYS OF VANADIUM IN URANIUM. Drain, L. E.; Hines, W. A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 357-358 of Magnetic Resonance and Related Phenomena. Vol. II. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The observation of the nuclear magnetic resonance of vanadium in solid solution in uranium is reported. The line width and structure of the resonance is attributed to a combination of quadrupole interaction and Knight shift anisotropy and the observation of the resonance at 4.2°K indicates that a transition to a magnetically ordered state has not occurred. (auth)

**28559** 'DIFFRACTION' AND MICROSCOPY IN SOLIDS AND LIQUIDS BY NMR. Mansfield, P.: Grannell, P. K.; Maudsley, A. A. (Nottingham Univ. (UK)). pp 431-432 of Magnetic Resonance and Related Phenomena. Vol. II. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th amperè congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

A new approach to the study of structure in solids and liquids by pulsed NMR is described. Examples of diffraction by ordered and disordered systems are given together with examples of two-dimensional image formation, in which spin density micrographs are formed from their one-dimensional density projections. Factors affecting resolution are discussed. (auth)

**28560** ANALYSIS OF ESR LINEWIDTHS IN PdEr AND PdDy. Zingg, W.; Buttet, J.: Hardiman, M. (Geneva Univ. (Switzerland)). pp 447-448 of Magnetic Resonance and Related Phenomena. Vol. II. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

Linewidths measurements by ESR on PdEr and PdDy dilute single crystals are analyzed in terms of Redfield-Hirst's theory as a function of temperature and magnetic field orientation. In PdEr the results fit well with an isotropic exchange parameter $|J_{sf}|$ = 6.1 ± .4 meV (6.4 ± .7 MeV in PdDy). (auth)

**28561** WELDABILITY STUDIES ON HIGH PERFORMANCE ALLOYS IN THIN SHEET FORM. Matthews, S. J. (Cabot Corp., Kokomo, IN). Weld. J. (N. Y.); 54: No. 9, 281.s-287.s(Sep 1975).

From 56th AWS annual meeting; Cleveland, OH (21 Apr 1975).

An investigation was undertaken to study the hot crack susceptibility of thin gage cobalt base and nickel base alloy sheet materials. Weldability tests were conducted on five different heats of Haynes alloy No. 188 (cobalt base) and on one heat of Haynes alloy 625, Hastelloy alloy X and Hastelloy alloy S (nickel base). Sheet gages ranged from 0.035 in. (0.9 mm) to 0.010 in. (0.25 mm) in thickness. Testing was accomplished using an arc spot hot crack susceptibility device. It was found that hot cracking increases as sheet thickness decreases; however, this was shown to be related to the number of grains per cross section rather than thickness, per se. Hot cracking was the most severe when the thickness-to-grain diameter ratio diminished to value of less than 4. Fractographic studies on the cobalt base alloy suggest this may be due to greater ease of intergranular crack propagation when there are only a few grains through the cross section of the sheet. This hypothesis is supported by the observation that the longest individual heat-affected zone cracks were generally found in those materials with the lowest thickness-to-grain diameter ratio. (auth)

**28562** DEFECT STRUCTURE OF ALUMINUM RICH Al–Mo ALLOYS. van Tendeloo, G.; van J. Landuyt; Amelinckx, S. (Univ. of Antwerp, Belgium). Mater. Res. Bull.; 10: No. 9, 941-948(Sep 1975).

The Al-rich end of the Al–Mo system was studied by electron diffraction and electron microscopy. Both $Al_4Mo$ and $Al_5Mo$ exhibit a remarkable defect structure. The monoclinic $Al_4Mo$ phase contains characteristic inversion domains. The dihexagonal $Al_5Mo$ phase shows twinning on the (001) plane. Different stacking variants of the $Al_5Mo$ structure corresponding with different compositions, were directly revealed by electron microscopy and Edax measurements. The formation of these phases from the $Al_5Mo$ structure is similar to that of shear structures in complex oxides. (auth)

**28563** EFFECTS OF COMPOSITION ON SITE ORDERING AND LOW TEMPERATURE PROPERTIES OF $Nb_2Al$ TYPE SIGMA PHASES. Brown, P. W. Madison, WI; Univ. of Wisconsin (1975). 298p. University Microfilms Order No. 75-16,302.

Thesis (Ph. D.)

A sigma phase exists in the Nb–Al binary system between 32 and 37 at. percent Al and corresponds to the formula $Nb_2Al$. In view of the varying values reported in the literature, the superconducting critical temperature of stoichiometric $Nb_2Al$ was measured. Similar measurements were also carried out on samples whose compositions spanned the $Nb_2Al$ single-phase region. In all cases the presence of superconductivity was not detected. The nature of the site ordering within this material was also examined. It was observed that the Al atoms prefer the sites with lower coordination while the Nb atoms prefer the more highly coordinated sites. The Ta–Al system also exhibits a sigma phase. In this system this phase is very stable, existing between 20 and 40 at. percent Al. Critical temperature measurements made on

samples whose compositions spanned the single phase region again failed to reveal the presence of superconductivity. Ordering studies indicated that stoichiometric $Ta_2Al$ exhibits the same ordering scheme as stoichiometric $Nb_2Al$. At compositions to the left of stoichiometry, the excess Ta was found to substitute into the A and D sites in a random way. Al substitution was found to occur first into E sites and then into C sites at compositions to the right of stoichiometry. Similar behavior was observed for $Nb_2Al$. The presence of a sigma-like phase has been reported in the Nb–Ga binary system. Since the sequence of intermetallic phases on the Nb rich side of this system was uncertain, x-ray analyses were conducted on samples of varying composition within this region. These revealed the presence of phases whose stoichiometries are $Nb_3Ga$, $Nb_5Ga_3$, and $Nb_5Ga_4$. No phase corresponding to $Nb_3Ga_2$ was detected. The nature of the order within the $Nb_5Ga_3$ structure was found to be consistent with the presence of superconductivity in this material. (Diss. Abstr. Int., B)

**28564** MECHANICAL PROPERTIES AND DISLOCATION SUBSTRUCTURE IN TANTALUM–RHENIUM–NITROGEN ALLOYS. Shields, J. A. Jr. Cleveland; Case Western Reserve Univ. (1975). 239p. University Microfilms Order No. 75-19,245.

Thesis (Ph. D.).

High purity Ta and Ta–Re alloy single crystals oriented for [1 anti 1 1] (011) slip, along with identical alloys doped with a constant background of approximately 300 ppMa N, were tested in tension at 77°K. Hardening observed in purified Ta–Re alloys consists of both thermal and athermal components. The thermal component possesses a linear hardening rate for compositions within the range 0-4 at. percent. The observed alloy softening cannot be accounted for on the basis of Re–N and $Re_2N$ clusters, and no evidence for large scale precipitation reactions was observed in any of the N-containing alloys. The addition of either N or Re to Ta results in a reduction of secondary dislocation and debris density and an increase in primary dislocation density. Re changes the dislocation substructure much more rapidly than does N. This implies that the concepts of stress-equivalence of dislocation substructures cannot be directly extended to substructures formed in interstitial bcc alloys. Purified Ta specimens having various orientations were deformed in both tension and compression at 4.2°K. Adiabatic slip was the dominant mode of deformation in tension, except for orientations near [001], where twinning occurred. Anomalous (anti 101) slip occurred in tension, but its extent was no greater than that observed at 77°K. In compression, the dominant mode of deformation was twinning. A pronounced effect of normal stress on the CRSS for twinning in compression was observed. The normal stress effect on twinning is consistent with the concepts of twin nucleation in bcc metals proposed by Sleeswyk. Addition of up to 4 percent Re to Ta eliminates twinning at 77°K, and promotes the occurrence of slip at 4.2°K for orientations displaying only twinning in unalloyed specimens. This effect is most probably related to the effects of solute atoms on the extended screw dislocation core, which inhibit the transformation of the core into the three-layer twin configuration. (Diss. Abstr. Int., B)

**28565** EFFECT OF HEAT TREATMENT ON THE MICROSTRUCTURE AND THE MECHANICAL PROPERTIES OF HIGH-TEMPERATURE NICKEL-BASE-SUPERALLOYS. Schubert, R. (Deutsche Edelstahlwerke A. G., Krefeld (F. R. Germany). Forschungsinstitut); Horn, E. (August Thyssen-Huette A. G., Duisburg (F. R. Germany). Forschung Werkstoffe und Metallkunde). Thyssen-Tech. Ber.; 6: No. 1, 43-52(1974). (In German).

16 figs.; 1 tab.; 16 refs.

A review is presented of heat treatment applied to high-temperature nickel-base-superalloys as a function of the volume percent of the $\gamma'$-phase. Heat treatment schedules are included. $\gamma'$-morphology and $\gamma'$-distribution as well as their effect on mechanical properties are examined. Values obtained from tensile tests up to 1,000°C are given along with results obtained from creep tests. Limitation for the heat treatment of alloys having an unstable $\gamma'$-phase is noted. Alloys X 5 NiCrTi 26 15, ATS 270 (approximately INCO 718), NiCr 20 TiAl, NiCr 20 Co 18 Ti, ATS 342 (approximately Waspaloy), ATS 354 (approximately Udimet 520), NiCo 20 Cr 15 MoAlTi, ATS 382 (approximately Udimet 710), ATS 381-G (approximately Mar M 246), FIS 145 and ATS 391-G (approximately IN 100) are included in the review. (GE)

**28566** STUDY IN COMPACTIBILITY OF POWDERS. Andreeva, N. V.; Radomyselskii, I. D.; Shcherban, N. I. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 32-42(Jun 1975). (In Russian).

Compactibility of commercial powders with different types of bond, electronic, and crystal structures is examined. It is shown that the dependence of the pressed parts density on the pressing pressure is of the same type for all the studied powders and for certain stages it can be described by an equation of logarithmic or power type. The physical basis of the constants in the suggested equations is found. The values of the straight lines angular coefficients for certain stages, and corresponding ultimate pressures are found to vary with a change in the compaction mechanism and to be determined by the electronic structure of the elements. The data on compressibility of solid bodies at high pressures under conditions of static or dynamic loading being involved, some processes observed during powder compacting may be explained. A method is suggested for estimating compactibility of powders from the density value with the pressure ultimate for the first stage of pressing; the pressure being numerically equal to the yield limit of the particles material. (auth)

**28567** STUDY OF INTERDIFFUSION OF CADMIUM AND NICKEL. Terent'ev, N. K.; Pozin, Yu. M.; Ryzhkov, E. M.; Solov'eva, K. M. Porosh. Met., Akad. Nauk. Ukr. SSR; No. 5, 87-92(May 1975). (In Russian).

Average (chemical) and partial coefficients of cadmium and nickel diffusion are determined experimentally at a temperature of 270°C. The cadmium diffusion rate in the investigated range of temperature and concentrations of nickel and cadmium as that of nickel. A volumetric effect arising during sintering of pressed parts of cadmium and nickel powders is explained by a considerable difference in the partial coefficients. (auth)

**28568** EFFECT OF TITANIUM AND ZIRCONIUM ON FORMATION AND PROPERTIES OF W–Cu PSEUDOALLOYS. Gorskii, V. V.; Lesnik, N. D.; Minakova, R. V.; Teodorovich, O. K.; Flis, A. A. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 53-60(May 1975). (In Russian).

The effect of alloying elements is studied as applied to regularities of the processes of spread formation of the W–(Cu–Zr), (Cu–Ti)-melt interface. Microdiffraction, microdurometric, and micro-x-ray spectrum studies were performed for the system W–(Cu–Zr), (Cu–Ti)-melt in experiments on spread and for the respective compositions within a wide range of alloying elements content. Titanium and zirconium, being interface-active, increase an adhesion strength of the interface. These elements, influencing the interaction in the tungsten-copper system, determine the distribution pattern of the components in the phases of the compositions, their structure and properties, increase hot hardness, thus creating preconditions for increasing heat resistance of the W–Cu pseudoalloys. (auth)

**28569** BOILING POINTS OF THE RARE EARTH METALS. Johansson, B. (Foersvarets Forskningsanstalt, Stockholm). J. Phys., F (London); 5: No. 6, 1241-1247(Jun 1975).

It is shown that the quasi irregular behaviour of the boiling points of the rare earth metals is due to the divalent free atomic configuration found for many of these elements. By application of Trouton's rule a quantitative study of the boiling temperatures is undertaken. (auth)

**28570** INTERNAL FRICTION OF Nb-1 AT. % SUBSTITUTIONAL ALLOYS. Szkopiak, Z. C.; Smith, J. T. (Surrey Univ., Guildford, Eng.). J. Phys., D (London); 8: No. 11, 1273-1284 (1 Aug 1975).

The effect of separate additions of 1 at. % of 13 different substitutional solute atoms on the internal friction spectrum of niobium containing oxygen and nitrogen as interstitial solutes was studied at a frequency of 1 Hz. The substitutional solute atoms interact elastically and chemically with the interstitial solute atoms forming s-i complexes. The effect of the s-i interactions is to reduce the oxygen and nitrogen Snoek (Physica; 8: 711 (1941)) peaks (sometimes to zero) and to introduce into the spectrum new subsidiary peaks caused by relaxations of the s-i complexes. The substitutional solute atoms have been classified into three groups according to their effects on the internal friction spectrum. This classification can be justified in terms of the following factors: size factor, modulus factor, chemical affinity, and first ionization potential. It has been found that the s-i interactions within each group of the solute atoms are affected by the size factor, modulus factor, chemical affinity and the first ionization potential, in general, in this order of importance. (auth)

**28571** SIMPLIFIED PREDICTION OF $K_{Ic}$ FROM TENSILE DATA. Baskes, M. I. (Sandia Labs., Livermore, CA). Eng. Fract. Mech.; 7: No. 2, 249-251(Jun 1975).

A previously developed theory of fracture toughness is extended so that the plane strain fracture toughness $K_{Ic}$ may be calculated by a simple integration of uniaxial tensile data. $K_{Ic}$ values calculated by this procedure for the alloys U–0.75Ti, U–2.25Nb, and Be S-200E are within 3% of the values obtained by the previous theory. (auth)

**28572** ELECTRICAL RESISTIVITY OF LIQUID SODIUM + LITHIUM MIXTURES. Evidence for Incipient Immiscibility.

Down, M. G.; Hubberstey, P.; Pulham, R. J. (Univ. of Nottingham, Eng.). J. Chem. Soc. (London), Faraday Trans., I; 71: 1387-1391(1975).

The electric resistivity of liquid sodium + lithium solutions was accurately determined by a capillary method from 100 to 450°C. The resistivity obeys a parabolic relationship over almost the full concentration range, but slight deviation occurs near the sodium axis. The excess resistivity of the solutions over that of the linear interpolation between the pure metals is relatively small. Comparison with the other alkali metals shows that the excess resistivity increases in the order Na + Li < Na + K < Na + Rb < Na + Cs. The temperature coefficient of resistivity, $d\rho/dT$, shows a peak near 63 mole % Li but only at temperatures just above 305°C. This is attributed to incipient immiscibility. At higher temperatures the coefficient changes smoothly from Na to Li. (auth)

**28573** ADHESIVE JOINTS OF CERAMIC MATERIALS AND REFRACTORY METALS. Elssner, G.; Pabst, R. (Max-Planck-Institut fuer Hirnforschung, Frankfurt am Main). Proc. Br. Ceram. Soc.; No. 25, 179-186(May 1975).

From joint meeting of the Basic Science Section of the British Ceramic Society and the Materials and Testing Group of the Institute of Physics on mechanical properties of ceramics; London, Eng. (17 Dec 1974).

Adhesive joints consisting of niobium metal and different aluminas are manufactured at temperatures < 1400°C by high vacuum solid-state bonding without formation of an intermediate layer. Using notched bend test specimens, the influence of welding parameters (welding time, bonding pressure) and the microstructure of the ceramic component on the bond strength is measured by $K_{ICV}$ factors, which characterize the fracture resistance of the bond. Three types of fracture paths are found which are dependent mainly on the ceramic microstructure. The data are supported by SEM micrographs of the fracture faces corresponding to the fracture paths. (auth)

**28574** CONTACT CHARGE DENSITY IN TRIVALENT DYSPROSIUM INTERMETALLICS THROUGH APW CALCULATIONS. Belakhovsky, M. (CEA-CEN, Grenoble, France); Ray, D. K. Solid State Commun.; 17: No. 3, 349-352(1 Aug 1975).

Using the augmented plane wave (APW) method, the conduction electron charge densities at the dysprosium nucleus (contact density) are calculated for the three intermetallic compounds DyZn, DyCu, DyRh. Results are in good agreement with experimentally measured Moessbauer isomer shifts. Core electronic contributions are discussed. (auth)

**28575** PHASE COMPOSITION, STRUCTURE, AND PROPERTIES OF MARAGING STEEL Kh14K9N6M5. Lashko, N. F.; Zaslavskaya, L. V.; Nikol'skaya, V. L.; Solov'eva, G. G. (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Met. Sci. Heat Treat.; 16: No. 9-10, 856-859(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 35-39(Oct 1974).

Three stages of aging are observed in cast maraging steel Kh14K9N6M5 quenched to martensite and retained austenite. In the first stage (up to 550°), martensite decomposes into two solid solutions—ferromagnetic (rich in iron) and nonferromagnetic (rich in chromium) with highly dispersed R phase in the latter. In the second stage (550°, 3-50 h), the two solid solutions and R phase that can be detected in powder patterns are retained. In the third stage, only the intermetallic R phase is precipitated (at temperatures ≥ 600 and 550° for 100 h). The highest strength corresponds to decomposition of the solid solution with formation of $\alpha$ phase rich in chromium and with highly dispersed R phase in it. (auth)

**28576** REASONS FOR THE FORMATION OF CRACKS IN BORIDE COATINGS ON STEEL. Rile, M. (Dresden Technical Univ.). Met. Sci. Heat Treat.; 16: No. 9-10, 836-838(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 20-23(Oct 1974).

Three types of cracks occur in boride coatings on steel: cracks parallel to the surface, cracks perpendicular to the surface down to the FeB—$Fe_2B$ interface, and cracks perpendicular to the surface down to the base metal. Opposing residual stresses occur in borides: tensile stresses in FeB and compressive stresses in $Fe_2B$. The residual stresses are due to the difference in the coefficients of thermal expansion of FeB, $Fe_2B$, and the steel. At 200-600°, the expansion coefficient of FeB is considerably higher than that of pure iron. The residual stresses resulting from the difference in the expansion coefficients lead to cracks of the first type when the thickness of FeB is large as compared with the total thickness of the coating. Cracks of the second type occur when the thickness of FeB is small. Cracks of the third type occur mainly after quenching of borided parts. FeB can be prevented from forming by changing the boriding technique. Then cracks of the first and second types do not occur. Due to the high compressive stresses in the $Fe_2B$ on alloy steels the coating of $Fe_2B$ may peel when the thickness of the coating is large. The residual stresses in $Fe_2B$ depend on the composition of the base metal and the boriding temperature. The composition of the saturating mixture has no effect. (auth)

**28577** EFFECT OF COBALT ON AGING OF MARTENSITE AND FERRITE IN Fe—Co—W AND Fe—Co—Mo ALLOYS. Edneral, A. F.; Zhukov, O. P.; Perkas, M. D. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Met. Sci. Heat Treat.; 16: No. 9-10, 840-843(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 24-28(Oct 1974).

The addition of cobalt to maraging Fe—Co—W and Fe—Co—Mo alloys broadens the $\gamma$ region at high temperatures, which permits the $\gamma \rightarrow \alpha$ transformation by the martensite mechanism during subsequent cooling. The high density of dislocations and other defects that result from the displacement mechanism of the $\gamma \rightarrow \alpha$ transformation leads not only to hardening of the matrix but also creates conditions favorable for the formation of large numbers of centers for precipitation of phases during aging. Cobalt substantially accelerates the aging process. The initial stage of aging is slowed down in alloy V10, but there is no incubation period in alloys V10K10 and V10K15, which may indicate a small effect of activation barriers determining the formation of precipitates on dislocations. (auth)

**28578** STRUCTURAL CHANGES DURING AGING OF MARAGING STEEL 03Kh11N10M2T. Spiridonov, V. B.; Fridman, V. S.; Rodionov, Yu. L.; Gruzin, P. L. Met. Sci. Heat Treat.; 16: No. 9-10, 844-848(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 28-32(Oct 1974).

Electron microscopic and Moessbauer spectroscopic studies showed that aging of steel 03Kh11N10M2T (10.5% Cr, 9.8% Ni, 2.2% Mo) produces complex structural changes due to redistribution in martensite of titanium, molybdenum, nickel, and chromium atoms, and precipitation of $Ni_3Ti$ even with brief holding (5 s at 525°). Also, a partial $\alpha \rightarrow \gamma$ transformation occurs in previously deformed samples during aging at 525°. There are good correlations between the structural changes and the changes observed in the properties of steel 03Kh11N10M2T during aging. (auth)

**28579** REFINING OF THE STRUCTURE OF MARAGING STEELS 03Kh11N10M2T AND 03Kh11N10M2TK6. Fokina, A. E.; Smirnov, L. V.; Sadovskii, V. D. (Inst. of Physics of Metals, Moscow). Met. Sci. Heat Treat.; 16: No. 9-10, 849-851(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 32-35(Oct 1974).

Formation of austenite in maraging stainless steels 03Kh11N10M2T and 03Kh11N10M2TK6 was studied in order to correct a coarse-grained structure. Samples were subjected to a wide range of heating rates in the critical $\alpha \rightarrow \gamma$ transformation range. Structural recrystallization was found to occur not in the transformation but at a higher temperature. Carbon has a substantial effect on the recrystallization temperature. (DLC)

**28580** PHASE COMPOSITION OF TUNGSTEN—MOLYBDENUM HIGH-SPEED STEELS WITH COBALT. Popandopulo, A. N. (Leningrad Polytechnical Inst.). Met. Sci. Heat Treat.; 16: No. 9-10, 799-801(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 67-68(Sep 1974).

Five high-productivity, high-speed steels containing 4% Cr, 2% V, 8% Co, 0.4 to 18% W, and 1 to 6% Mo were studied. Phase analysis was performed using anodic separation of carbides and x-ray diffraction. No hardening by intermetallic compounds occurs in cobalt steels with moderate to small amounts of W. (DLC)

**28581** DETERMINING THE OPTIMAL COMBINATION OF MECHANICAL PROPERTIES OF STEELS TO ENSURE RELIABLE MATERIALS FOR TANKS. Beilinova, T. A.; Burnos, V. A.; Nechai, G. E. Met. Sci. Heat Treat.; 16: No. 9-10, 805-807 (1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 71-73(Sep 1974).

For steels 38KhA, 40KhNMA, and 30KhMA tempered at 400-600°, there is a linear relationship between $\sigma_b$ and $a_p$ and also between $\sigma_b$ and $a_n$. The correlation is 0.97-0.99. These relationships hold true on condition that the structure is of the same type—temper sorbite (troostite). For the critical value ($a_p$ = 2 kg-m/cm² at −50°) the maximum permissible strength is 120 kg/mm² for steel 38KhA, 138kg/mm² for 40KhNMA, and 113 kg/mm² for 30KhMA. (auth)

**28582** PROPERTIES OF NICKEL IN RELATION TO AMOUNT OF OXIDE PHASE. Portnoi, K. I.; Lyukevich, V. I.; Babich, B. N. Met. Sci. Heat Treat.; 16: No. 9-10, 780-782(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 55-57(Sep 1974).

The effects of a hardening phase (1 to 4% $HfO_2$) on the mechanical properties and structure of Ni were investigated. Both short- and long-term strengths were measured. Ultimate and yield strengths increase almost linearly with $HfO_2$ content, while elongation decreases sharply until 1.15% $HfO_2$ is reached. Structural stability increases. Results show only small effects, and the amount of hardening phase cannot be the determining factor in obtaining high heat resistance. (DLC)

**28583** MECHANICAL PROPERTIES OF TITANIUM ALLOYS UNDER CONDITIONS OF BIAXIAL TENSION AT LOW TEMPERATURES. Il'ichev, V. Ya. Savva, S. P.; Sidorov, N. G.; Morozov, B. S.; Bel'chich, E. M. (Physicotechnical Inst. of Low Temperatures, Kharkov). Met. Sci. Heat Treat.; 16: No. 9-10, 774-775(1974).

Translated from Metalloved. Term. Obrab. Metal.;16: No. 9, 50-51(Sep 1974).

Strength and ductility of single-phase (VT5-1kt[5% Al] and AT2 [1.33% Mo, 3% Zr]) and two-phase (VT6s [5% Al, 4% V] and VT14 [3.5-6% Al, 1% V, 3% Mo]) Ti alloys were tested in biaxial tension at 20 to 293°K. AT2 is the most ductile. Fracture characteristics are also described. (DLC)

**28584** MECHANICAL PROPERTIES AND STRUCTURE OF $\beta$ ALLOYS ON THE Ti-3% Al-Cr SYSTEM. Ushkov, S. S.; Ivanova, L. A. Met. Sci. Heat Treat.; 16: No. 9-10, 769-773 (1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 45-50(Sep 1974).

Ti-3% Al alloys containing 0 to 25% Cr or 0 to 35% V were investigated. (DLC)

**28585** GRAIN-BOUNDARY STRUCTURE IN AN AUSTENITIC STAINLESS STEEL. Howell, P. R.; Jones, A. R.; Ralph, B. (Cambridge Univ., Eng.). J. Mater. Sci.; 10: No. 8, 1351-1359 (Aug 1975).

To what extent the grain-boundary structure in a commercial material may be understood in terms of modern structural theories of crystal boundaries is considered. In one particular state (partially recrystallized) 78% of the boundaries, examined by transmission electron microscopy, could be said to contain the type of structure predicted by the theoretical approach (i.e. intrinsic dislocation arrays). Not only the "equilibrium" component of the boundary structure (intrinsic dislocation arrays) but the perturbations created in this component by the presence of other, "non-equilibrium" components (such as topographical discontinuities, precipitates and extrinsic dislocations produced by the dissociation of "run-in" matrix dislocations) are considered. (auth)

**28586** BRITTLENESS AND CHARACTERISTICS OF THE FRACTURE OF $\beta$ TITANIUM ALLOYS. Gorynin, I. V.; Chechulin, B. B.; Ushkov, S. S.; Belova, O. S. Met. Sci. Heat Treat.; 16: No. 9-10, 761-764(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 37-40(Sep 1974).

Brittleness of $\beta$ titanium alloys with 3% Al, 13% V, 11% Cr, etc. is characterized by the same relationships as for iron-base alloys—a ductile-brittle transition temperature at a given impact toughness and limit ductility, approach of the ultimate and yield strengths to the same value at low temperature, appearance of brittle facets similar to the crystalline components in the fractures of steel samples, shift of the ductile-brittle temperature with changes in deformation rate, grain size, purity of the metal, scale of the samples, and cold working. It was found that $\beta$ titanium undergoes brittle fracture, the facets are sections of brittle fracture, and the facets can be used to judge the susceptibility of $\beta$ titanium to brittle fracture. The similarity of brittleness in metals with a bcc lattice was confirmed on the basis of $\beta$ titanium and iron. The nature of brittleness is the same in $\beta$ titanium-based and in iron-based alloys. (auth)

**28587** DUCTILITY AND MECHANICAL PROPERTIES OF CAST LIGHTLY WORKED HIGH-SPEED STEELS. Khazanov, I. O.; Korzunin, Yu. K. (Tomsk Polytechnical Inst., USSR). Met. Sci. Heat Treat.; 16: No. 9-10, 758-760(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 33-36(Sep 1974).

Optimum temperature conditions were determined for forging and rolling of cast steels. Of the steels investigated, the ductility and the bending strength as-cast are highest for steels R12, R4M5K8, and R6M5K5. The mechanical strength of these steels increases greatly after 40-50% deformation. (auth)

**28588** EFFECT OF CARBON ON THE PHASE COMPOSITION AND PROPERTIES OF Fe-Co-W ALLOYS. Brostrem, V. A.; Kremnev, L. S. (Moscow Machine-Tool Inst.). Met. Sci. Heat Treat.; 16: No. 9-10, 750-754(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 9, 25-30(Sep 1974).

In alloys with 18% W and 25% Co, the addition of carbon in amounts up to 0.74% has no effect on the temperature range of the $\alpha \rightarrow \gamma$ transformation. For all alloys investigated, this range is 920-960°, since the alloys do not contain carbide phases easily dissolved during heating ($M_{23}C_6$, $M_3C$). No metastable $M_{23}C_6$ is observed in Fe-Co-W-C alloys; along with $M_6C$, one observes $M_6C'$ with a smaller lattice constant (11.10 Å for $M_6C$ and 10.89 Å for $M_6C'$). WC is observed in alloys with 0.74% C (W/C = 1.57), which are observed in the Fe-W-C system only after prolonged annealing. Carbon increases the secondary hardness of these alloys, although with over 0.23% C (W/C < 5.1) the resistance to tempering decreases substantially, and therefore the amount of carbon should not exceed 0.23% in order to obtain good cutting properties. (auth)

**28589** X-RAY METALLOGRAPHIC ANALYSIS OF Mo SUBJECTED TO SHOCK-WAVE AND LASER-BEAM ACTION. Smyslov, E. F.; Davydov, G. V.; Alebastrova, E. P. (Moscow State Pedagogical Inst.). Dokl. Akad. Nauk BSSR; 19: No. 5, 435-438(May 1975). (In Russian).

X-ray metallurgical data and microhardness measurements were used to determine structural changes in powdered Mo after action on it of shock waves and laser beams. Both agents caused sintering in monolithic samples. Four similarities and differences in structure are considered. On the samples treated with shock waves, confirmation was obtained of the correspondence of the profile of the physical widening of x-ray lines with different functions of the distribution of the intensity along the angle of dispersion. The most satisfactory approximation was obtained with the use of the function $\sin^2[(\pi x/B)/(\pi x/B)^2]$. (tr-auth)

**28590** PHASES PRECIPITATED IN GRAIN BOUNDARIES DURING SLOW COOLING OF MARAGING STEELS. Chernyavskaya, S. G.; Rusinovich, Yu. I.; Fridman, V. S.; Krasnikova, S. I.; Drobot, A. V.; Lednyanskii, A. F.; Lapin, P. G. (Dnepropetrovsk State Univ., USSR). Met. Sci. Heat Treat.; 16: No. 9-10, 862-863(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 45-47(Oct 1974).

Maraging steels ÉP678, ÉP679, and ÉP699 cooled slowly from 1250° show precipitates of various phases in the grain boundaries, mainly titanium carbonitrides, the size and quantity of which increase with cooling. With cooling to 950-850°, there are also particles that consist of titanium with oxygen, nitrogen, and carbon. These particles in the grain boundaries can cause embrittlement of the steels. (auth)

**28591** STABILIZATION OF AUSTENITE IN HIGH-SPEED STEELS HELD ABOVE $M_s$. Geller, Yu. A.; Brimene, V. P. (Moscow Machine-Tool Inst.). Met. Sci. Heat Treat.; 16: No. 9-10, 894-896(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 73-75(Oct 1974).

It was found that for high-speed steels held above $M_s$, the transformation of austenite is delayed during further cooling below $M_s$ to room temperature and the amount of austenite in the quenched steel increases. The effect of stabilization varies with the temperature and increases as the holding temperature approaches $M_s$. Indirect methods showed no diffusion redistribution of carbon or alloying elements between separate microvolumes of austenite in the process of brief holding near $M_s$. The effect due to holding above $M_s$ (240-260°) can be used to reduce the distortion of tools during quenching. (auth)

**28592** PHASE DIAGRAM OF THE SYSTEM Pr-Ge. Eremenko, V. N.; Xuong Quok Che; Buyanov, Yu. I.; Khar'kova, A. M. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater.: 11: No. 1 133-135(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 160-162(Jan 1975).

Microstructural, differential thermal, and X-ray phase analysis were used to study Pr-Ge phase equilibria throughout the concentration range. The phase diagram constructed show the following compounds: $PrGe_{2-x}(x \sim 0.4)$, PrGe, $Pr_{1-y}Ge(y \sim 0.1)$, $Pr_5Ge_4$, $Pr_4Ge_3$, $Pr_5Ge_3$, and $Pr_3Ge$. Crystal structures of the compounds were determined. (DLC)

**28593** CRYSTAL-FIELD EFFECTS ON THE 4f-INDUCED HYPERFINE FIELD ON SAMARIUM IN FERROMAGNETIC COMPOUNDS. Malik, S. K.; Vijayaraghavan, R. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., B; 12: No. 3, 1098-1100(1 Aug 1975).

It is shown that in ferromagnetic samarium compounds, the crystal fields not only affect the magnitude of the 4f-induced hyperfine field (H/sub 4f/) at the samarium nuclear site, but may also make it negative in contrast to the positive H/sub 4f/ in the case of the free $Sm^{3+}$ ion. (auth)

**28594** CRITICAL BEHAVIOR OF AMORPHOUS MAGNETS. Aharony, A. (Harvard Univ., Cambridge, MA). Phys. Rev., B; 12: No. 3, 1038-1048(1 Aug 1975).

Renormalization-group techniques are applied to a model Hamiltonian recently proposed by Harris, Plischke, and Zuckermann for the description of amorphous magnets. In this model, a single-ion uniaxial anisotropy, with a random direction of the axis of anisotropy, is introduced. Averaging over this random variable yields an (translationally invariant) effective Hamiltonian, in which the m-component spin variable is replaced by an nm-component vector, and n is finally set equal to zero. Contrary to the result for an isotropic random perturbation, the fixed-point describing the nonrandom m-component critical behavior is unstable with respect to terms in the Hamiltonian generated by the randomness, the appropriate crossover exponent being given exactly by (2 phi/sub m/-2 + alpha/sub m/), where phi/sub m/ is the Fisher-Pfeuty anisotropic spin crossover exponent and c/sub m/ is the specific-heat exponent. Depending on the distribution function for the random anisotropy directions, there are seven or thirteen other fixed points. Most of these are unstable, and the recursion relations probably yield a "runaway" which is interpreted as a smeared transition. Experiments on amorphous $TbFe_2$ are discussed. (auth)

**28595** LOW-TEMPERATURE PHASE TRANSITION AND ISOMER-SHIFT SYSTEMATICS IN INTERMEDIATE PHASES OF RARE-EARTH-GOLD COMPOUNDS. Kimball, C. W. (Northern Illinois Univ., DeKalb); Dwight, A. E.; Kalvius, G. M.; Dunlap, B.; Nevitt, M. V. Phys. Rev., B; 12: No. 3, 819-823 (1 Aug 1975).

The temperature dependence of the $^{197}Au$, $^{166}Er$, and $^{169}Tm$ Moessbauer effect was studied in intermediate phases of RAu (R equals Sc, Ho, Er, Tm, Yb, Lu) with the CsCl structure. Results indicate that the CsCl structure is metastable and undergoes a low-temperature martensitic phase transformation to a close-packed (FeB-like) structure. The ratio of the quantity of the two phases present at 4.2°K for various compounds is obtained. Moessbauer-absorption patterns for $^{166}Er$ in ErAu have a temperature dependence which is characteristic of relaxation effects. Isomer-shift systematics for $^{197}Au$ in RAu for the CsCl and the transformed close-packed phases are discussed. (auth)

**28596** SATURATION MAGNETIC MOMENTS, MAGNETIC HYPERFINE FIELDS AND ELECTRIC FIELD GRADIENTS AT NUCLEI IN THE HEAVY RARE EARTH METALS. Eagles, D. M. (Commonwealth Scientific and Industrial Research Organisation, Chippendale (Australia). National Measurement Lab.). Z. Phys., B; 21: No. 1, 79-87(May 1975).

The contributions of 4f, 5d and 6s electrons to the saturation magnetic moments and magnetic hyperfine fields in the heavy rare earth metals are calculated using the model described in the previous paper. The 4f shell moments are reduced from their free ion values by amounts varying from 0.05 $\mu_B$ in Gd to several tenths of a Bohr magneton in Tb and Dy, but that the calculated total saturation moments in Tb and Dy are slightly larger than commonly accepted experimental values. After 6s contributions to magnetic hyperfine fields are determined by fitting observations in Gd, the predicted differences between the fields for metals and those for free ions are such that the estimated uncertainty ranges of the theoretical values overlap the experimental ranges. The 5d contribution in the model is negative, varying from about -40 kOe in Tb to -200 kOe in Er. Electric field gradients are also analyzed. Observed results can be fitted if the average effective Sternheimer screening factor $R_d^*$ for 5d electrons in the metals satisfies $(1 - R_d^*)$ approximately 0.7. (auth)

**28597** REVISED MODEL FOR 5d ELECTRONS IN THE HEAVY RARE EARTH METALS. Eagles, D. M. (Commonwealth Scientific and Industrial Research Organisation, Chippendale (Australia). National Measurement Lab.). Z. Phys., B; 21: No. 1, 69-78(May 1975).

A revised version of a recently published model for 5d electrons in the ferromagnetic state of the heavy rare earth metals is described. The model involves the broadening of local 5d states into overlapping bands with individual widths W. It is assumed that the local 5d wave functions lie at some point between those for atomic $4f^n5d6s^2$ configurations and those calculated for such configurations subject to the restriction that the 4f shell is kept with its moment rigidly fixed in some given direction. The admixture of non-aligned 4f states as in the atom lowers the local energy, but it also lowers the 5d bandwidth due to misfit of the 4f states which occur with and without the presence of a 5d electron. This second effect raises the energy of the low lying states in the band. The best local states are determined by minimizing the total electronic energy of the system, using approximations which are most suitable for 4f shells with large excitation energies. Bandwidths are found by fitting the observed saturation magnetic moments in Gd and Tm, and satisfy $W \approx 1$ eV. (auth)

**28598** SUPERCONDUCTIVITY AND ELECTRICAL RESISTANCE OF Tl-$Tl_2Se$ FILMS CONDENSED AT 4°K. Hilsch, P. (Physikalisch-Technische Bundesanstalt, Braunschweig (F. R. Germany)). Z. Phys., B; 21: No. 1, 47-52(May 1975). (In German).

Tl-films with different additions of $Tl_2Se$ were condensed on a quartz plate at 4°K. The superconducting transition temperature and the normal resistance were studied as a function of the $Tl_2Se$-concentration. Approximately 25% of $Tl_2Se$ in Tl increased the transition temperature to 4.2°K. Annealing the films resulted in a pronounced maximum of the normal resistance versus temperature relation at about 240°K for $Tl_2Se$ concentrations above 30%. From this maximum the resistance drops rapidly-within a temperature rise of 10°K-to a small value. This is explained by crystallization of the $Tl_2Se$ component which was supposed to be in a liquid-like state before. (auth)

**28599** VERSATILITY OF APPLICATION OF COPPER-BERYLLIUM. Hoenig, A. (Vacuumschmelze G.m.b.H., Hanau (F. R. Germany)); Koeppen, H. (Brush-Wellman, Inc., 77-Fontainebleau (France). European Technical Center). Metall; 28: No. 11, 1059-1062(Nov 1974). (In German).

The versatility of copper-beryllium alloys has been shown by selected examples of application especially considering the favorable combining possibilities of properties. (GE)

**28600** SIMS STUDIES ON THE INFLUENCE OF SURFACE LAYERS UPON THE HYDROGEN PERMEABILITY OF TANTALUM FOILS. Zuechner, H.; Boes, N. (Muenster Univ. (F. R. Germany). Inst. fuer Physikalische Chemie). Z. Phys. Chem. (Frankfurt); 93: No. 1-6, 65-76(Nov 1974). (In German).

The technique of secondary ion mass spectrometry (SIMS) is used to get information about surface layers of tantalum foils which retard the hydrogen penetration, and about the elimination of these layers by outgassing the foils in ultrahigh vacuum at high temperatures and subsequent coating with a vapor deposited thin film of palladium. The SIMS-investigation shows that it is possible to eliminate oxygen and carbon almost entirely and also some other bulk impurities by the outgassing procedure. It can be shown as well that the formation of new oxide layers which cause again surface hindrance can be prevented by protecting the foils with an evaporated Pd-film. Samples which are outgassed only but not protected, in fact, take up oxygen again instantaneously from the atmosphere. (auth)

**28601** ELECTRIC QUADRUPOLE INTERACTION OF THE 75 keV STATE OF $^{100}Rh$ IN A BERYLLIUM MATRIX. Krien, K.; Soares, J. C. (Bonn Univ. (F. R. Germany). Inst. fuer Strahlen-und Kernphysik); Hanser, A.; Feurer, B. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F. R. Germany)). Hyperfine Interactions; 1: No. 1, 41-44(Jun 1975).

The quadrupole interaction frequency $\nu_q = eQV_{zz}/h = 8.92(9)$ MHz was observed for the 75 keV state of $^{100}Rh$ in a polycrystalline beryllium matrix by use of the $e^- - \gamma$ time differential perturbed angular correlation technique. The measured spin rotation pattern is hardly disturbed in spite of the fact that the source was produced by an isotope separator implantation of $^{100}Pd$ into a beryllium foil without any after-treatment. (auth)

**28602** NUCLEAR ORIENTATION OF $^{60}Co$ IN CONCENTRATED CoAu ALLOYS. Boysen, J.; Brewer, W. D.; Klein, E. (Freie Univ. Berlin (F. R. Germany). Fachbereich Physik). Hyperfine Interactions; 1: No. 1, 55-64(Jun 1975).

Beta and $\gamma$ angular distribution measurements are reported from $^{60}Co$ oriented in CoAu at low temperatures in applied fields up to 72 kOe and Co concentrations of 0.95 to 11 at. %. The results are explained by assuming a random molecular field interaction between groups of Co impurities. The hyperfine field on Co nuclei in groups of three or more nearest neighbors is negative and has a value near -180 kOe. The induced field on Co-pair nuclei is small and probably also negative. Complete polarization of the Co moments in the more concentrated alloys requires a very large applied field. (auth)

**28603** EQUIVALENCE OF PROPAGATOR AND LOCATOR APPROACH FOR THE AVERAGE-T-MATRIX APPROXIMATION. Feiner, L. F. (Rijksuniversiteit Utrecht (Netherlands). Instituut voor Theoretische Fysica). Phys. Lett., A; 53: No. 5, 349-350(14 Jul 1975).

The recently developed theory of disordered substitutional alloys is centered around the average t-matrix approximation (ATA) and the coherent-potential approximation (CPA) as methods for dealing with the tight-binding single band model Hamiltonian. It was emphasized that the CPA result for the configurationally averaged Green's function $\langle G(E) \rangle$ may be obtained both by

a locator and a propagator approach. It is shown that the same is true for the ATA if the calculation is started from the same reference system in both approaches. (auth)

**28604** EFFECT OF HIGH PRESSURE ON THE ELECTRIC FIELD GRADIENTS AT TWO INEQUIVALENT LATTICE SITES OF TANTALUM IN ω-ZIRCONIUM. Butz, T.; Kalvius, G. M. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.); Goebel, H. (Siemens A. G., Muenchen (F. R. Germany). Forschungslaboratorium); Holzapfel, W. B. (Max-Planck-Institut fuer Festkoerperforschung, Stuttgart (F. R. Germany)). Hyperfine Interactions; 1: No. 1, 1-14(Jun 1975).

The pressure variation of the electric field gradients at substitutional tantalum atoms on the two lattice sites (A and B) of ω-zirconium have been determined to be $(\partial \ln q^A/\partial P)_T = -1.05(26)10^{-3}$ $kbar^{-1}$ and $(\partial \ln q^B/\partial P)_T = +6.03(40)10^{-3}$ $kbar^{-1}$. In addition to thermal expansion coefficients of the unit cell of ω-Zr were found to be $\alpha_{||} = +3.5(3)10^{-6}$ $K^{-1}$ and $\alpha_{\perp} = +7.9(4)$ $10^{-6}$ $K^{-1}$. A combined analysis of the pressure dependence and the previously determined temperature dependence of the electric field gradients supports the assumption of two different bonding types at the A and B sites. (auth)

**28605** QUASI-TRIPLE COLLISIONS IN LOW ENERGY ION SCATTERING: A POSSIBILITY TO DETERMINE SURFACE DEBYE TEMPERATURES. Verhey, L. K.; Poelsema, B.; Boers, A. L. (Rijksuniversiteit Groningen (Netherlands)). Phys. Lett., A; 53: No. 5, 381-382(14 Jul 1975).

Calculations and measurements of energy spectra of 10 keV $Kr^+$ ions, scattered from Cu(100) face at different temperatures, are reported. One of the observed phenomena is the existence of a new peak. From the temperature behavior of this peak the surface Debye temperature is obtained. (auth)

**28606** ELECTRIC FIELD GRADIENT IN $Cd_{1-x}Mg_x$ FOR $0 \leq x \leq 0.15$ MEASURED BY PERTURBED ANGULAR CORRELATIONS. Butz, T.; Ernst, H. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.). Phys. Lett., A; 53: No. 5, 387-389(14 Jul 1975).

The dependence of the electric field gradient q in $Cd_{1-x}Mg_x$ on the axial ratio of the hcp unit cell yields the coefficient $(\partial \ln q/\partial \ln(c/a))_V = +6.2(1.0)$ at $x = 0$ in fair agreement with a point charge calculation. (auth)

**28607** CRITICAL EFFECT OF THE SURFACE DENSITY GRADIENT ON SURFACE PLASMON DISPERSION. Boardman, A. D.; Isaac, E. D. (Salford Univ. (UK)). Phys. Lett., A; 53: No. 5, 399-400(14 Jul 1975).

An analytical expression is given for the linear dispersion coefficient of surface plasmons on metals and semiconductors. The influence of the surface density profile in the selvage region is included by a model that yields a critical width. (auth)

**28608** SPIN RELAXATION RATES IN CuFe MEASURED BY NEUTRON SCATTERING. Loewenhaupt, M.; Just, W. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung). Phys. Lett., A; 53: No. 4, 305-306 (30 Jun 1975).

The absolute value and the temperature dependence of the spin relaxation rate of the Kondo system CuFe was deduced from the magnetic scattering of unpolarized neutrons with energy analysis. (auth)

**28609** INVAR EFFECTS IN $Zr_{0.7}Nb_{0.3}Fe_2$. Shiga, M. (Kyoto Univ. (Japan)). Phys. Lett., A; 53: No. 4, 319-320(30 Jun 1975).

A thermal expansion anomaly similar to that of the invar alloy was observed in a Laves phase intermetallic compound, $Zr_{0.7}Nb_{0.3}Fe_2$. This anomaly is explained as a result of a large spontaneous volume magnetostriction. Magnetic properties and magnetovolume effects of this material are discussed on the basis of the band model of ferromagnetism. (auth)

**28610** TRANSPORT OF FISSION PRODUCTS IN ZIRCALOY-2. Paul, A. R.; Agarwala, R. P. (Bhabha Atomic Research Centre, Trombay, India). pp 109-121 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

Using radioactive tracers the diffusion coefficients of cerium and neodymium in Zircaloy-2 were measured in the temperature range 616 to 1340°C for cerium and 620 to 1250°C for neodymium. The penetration profiles were determined by a serial sectioning technique. Some of the specimens were also analyzed by the residual activity method. Both the methods gave similar values of diffusivities. The temperature dependence of diffusivities determined from the tracers deposited as metal under high vacuum ($\sim 1.0 \times 10^{-6}$ torr) could be represented by a series of equations. It appears that the diffusion takes place by a dislocation mechanism. In the phase transformation region (780 to 980°C), the diffusivities could be represented by the relation $\log D = C_\alpha \log D_\alpha + C_\beta \log D_\beta$, where $D_\alpha$ and $D_\beta$ are the diffusivity values at a given temperature calculated by the extrapolation from the α and β-phases, respectively, and $C_\alpha$, $C_\beta$ are the respective concentrations of these two phases at that temperature. Since the plots of log D versus 1/T in this region were non-linear, it was not possible to determine any single value of activation energy. (auth)

**28611** INTERSTITIAL AND SUBSTITUTIONAL METALLIC IMPURITY DIFFUSION IN Zr AND Ti. Tendler, R. (Comision Nacional de Energia Atomica, Buenos Aires); Santos, E.; Abriata, J.; Varotto, C. F. pp 71-94 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Impurity diffusion measurements of $^{51}Cr$ in β−Zr, $^{65}Zn$ in both α−Zr and β−Zr and $^{59}Fe$, $^{60}Co$ and $^{115}Cd$ in α−Zr are reported, together with self-diffusion measurements of $^{44}Ti$ in dilute Ti(Ni) alloys. An analysis is made of available impurity diffusion data in zirconium. It is concluded that the interstitial-like or substitutional behavior of the impurities may be understood by a judicious use of Anthony and Turnbull conditions, atomic-size parameters, features of the corresponding phase diagram, and the Hume−Rothery rules controlling substitutional dissolution. It is shown that the interstitial-like mechanism does not necessarily mean a simple interstitial mechanism. (auth)

**28612** HIGH-TEMPERATURE THERMOPHYSICAL PROPERTIES OF W, Mo, Nb, AND Ta. Hoch, M. (Univ. of Cincinnati). pp 113-122 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Specific heat data for tungsten, molybdenum, niobium, and tantalum, obtained in various laboratories using calorimetry, extremely rapid transient techniques, and the modulation method, are compared and evaluated. For these elements, the data agree to within 1, 3, 5, and 3%, respectively, and confirm a previously developed equation for the specific heat of solids between room temperature and the melting point. Similarly, a comparison of the values of the total emittance measured by various methods, and also computed from electrical resistivity measurements, reveals close agreement in the case of molybdenum and tungsten, though not for niobium and tantalum. The thermal conductivity of the four metals was evaluated using values derived from diffusivity and direct conductivity measurements as well as some computed from lattice theory and utilizing available data on electrical resistivity. With the exception of niobium, the results are in good agreement. (auth)

**28613** PHASE DIAGRAMS OF THE TERNARY SYSTEMS U−Th−Mn, Fe, AND Ni IN A PART RICH IN U AND Th. Badaeva, T. A.; Aleksandrova, L. N. (Inst. of Metallurgy, Moscow). pp 265-274 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Results of experimental studies of phase diagrams of the ternary systems U−Th−Mn, −Fe and −Ni are presented. Thermal and microstructural analyses of the alloys were conducted and their hardness and microhardness were measured. Projections of the liquidus surfaces and phase diagrams are constructed and reaction diagrams drawn up. Zones of stratification exist in the liquid phase which spread to the ternary systems from the binary U−Th system and of four-phase eutectic equilibria in the vicinity of binary, uranium-rich eutectics of uranium with manganese, iron, and nickel. In the U−$UMn_2$−Th system, four-phase eutectic equilibrium exists at 730°C; there are also two four-phase peritectic equilibria, at 775°C and 740°C, and a peritectoid and a eutectoid equilibrium. The zone of stratification in the liquid phase spreads to the ternary system at manganese concentrations of up to approximately 18 at.% Mn. In the U−$UFe_2$−Th system, four-phase eutectic equilibrium is established at 720°C; there are two peritectic equilibria, at 805 and 800°C; in the solid phase two eutectoid equilibria are observed. There is no zone of stratification in the liquid phase, even at 2 at.% Fe. In the system U−$U_7Ni_3$− ThNi−Th, four-phase eutectic equilibrium exists at 735°C. In this system there are also two monotectoid four-phase equilibria, at 1650 and 1050°C, and five peritectic equilibria, at 1040, 1020, 800, 785, and 780°C; in the solid phase, eutectoid conversions are observed. The zone of stratifica-

tion in the liquid phase occupies a significant part of the system concentration range studied, reaching 36 at.% Ni and 64 at.% Th. (auth)

**28614** THERMODYNAMIC CALCULATIONS OF THE PHASE EQUILIBRIUM BOUNDARIES FOR TWO- AND THREE-COMPONENT BODY-CENTERED CUBIC SOLID SOLUTIONS OF URANIUM. Udovskii, A. L.; Ivanov, O. S. (Inst. of Metallurgy, Moscow). pp 285-302 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Models and basic approximations are offered for a thermodynamic description of two- and three-component isomorphous solid solutions. The various contributions made to the free energy of solid solutions formed by isomorphous components, such as the chemical contribution (using Becker's model), the contribution made by the energy of elastic deformation of the crystal lattice, the vibrational contribution, and that of thermally excited electrons are considered. The predominant part played in shaping the decomposition curves by the elastic component of the free energy is demonstrated, and the effects of the concentration and temperature dependence of the modulus of elasticity on the shape of the decomposition curves for the solid solutions are analyzed. Results are given for the calculation of: (a) decomposition curves (solubility curves) for eight systems of γ-uranium (with β-Zr, β-Hf, V, Nb, Ta, Cr, Mo, and W) and also for the system β-Zr-Nb; and (b) phase boundaries for the separation regions of body-centered cubic solutions in the ternary systems U-Nb-Mo and U-Nb-Zr. The interrelationship between the shape of the phase equilibrium boundaries for isomorphous solid solutions in two- and three-component systems are established along with the concentration relationships for some of the simplest physical characteristics, such as the coefficient of electron thermal capacity, Debye temperature, modulus of elasticity, and anharmonic characteristics. The main factors responsible for the shape of the asymmetric curves computed for decomposition and solubility are, for the systems U-Zr, U-Hf, U-Nb, and U-Ta, as follows: the elastic component of the free energy, which decreases as the temperature rises, the mixing energy at 0°K, and the configuration-entropy term. A further contribution is made by the vibration component of the free energy for the systems U-V, U-Cr, U-Mo, U-W, and Zr-Nb; the system U-Mo exhibits an additional factor of electron origin. (auth)

**28615** EXPERIMENTAL DETERMINATION AND THEORETICAL CALCULATION OF THE THERMODYNAMIC PROPERTIES OF BODY-CENTERED CUBIC SOLID SOLUTIONS OF URANIUM. Vamberskii, Yu. V.; Udovskii, A. L.; Ivanov, O. S. (Inst. of Metallurgy, Moscow). pp 321-336 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 2); CONF-741030-P2.

Data on the thermodynamic properties of solid solutions of uranium are extremely limited. The procedure and results of the experimental and theoretical study of the thermodynamic properties of U-Mo and U-Nb body-centered cubic solutions are described. The experimental studies were carried out using an emf method with a liquid electrolyte. The emf of the following Galvanic cells were measured in the 1048 to 1173°K temperature range. In the U-Mo system, the calculated dependence of $\Delta S^E$ practically reproduces the experimental curve; the calculated dependence of the enthalpy of the mixture is similar in slope to the experimental one. Calculation of the excess thermodynamic functions in the U-Nb system made it possible to predict the experimental concentration dependence of the excess entropy of the mixture (with change of sign) with satisfactory quantitative agreement. The physical reasons have been found for the sign changes of $\Delta S^E$ in both systems and for the sign change of ΔH in the U-Mo system. It was noted that the vibration component of the enthalpy of the mixture, excluding the zero-vibration energy, was different from zero only if anharmonicity was taken into account. The negative sign, obtained in the calculations, in the case of the elastic component of the excess entropy in the U-Mo system and for a niobium content higher than 40 at.% in the U-Nb system demonstrates the growth of elastic energy with increasing temperature, and is due to the predominant effect of the increase of difference in the lattice periods of pure components over the decrease in Young's modulus of the solid solutions. (auth)

**28616** THERMODYNAMICS OF FORMATION OF Th-Cu ALLOYS. Bailey, D. M.; Smith, J. F. (Ames Lab., IA). pp 355-365 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

Electromotive force cells have been used to determine the Gibbs free energies, enthalpies, and entropies of formation for $ThCu_6$, $ThCu_{3-\delta}$, $ThCu_2$, and $Th_2Cu$ over the temperature range 729 to 1219°K. Solid $CaF_2$ was used as the electrolyte. Comparison of the present measurements with earlier measurements on the most copper-rich phase shows that the free energies are reproducible by this technique to approximately 4 percent. The magnitudes of the entropies of formation were all measured as less than 1 cal/g-atom · °K and are therefore physically reasonable. The values for the entropies of formation of $ThCu_6$ and $ThCu_{3-\delta}$ were found to be positive, that of $ThCu_2$ to be essentially zero, and that of $Th_2Cu$ to be negative. Comparison with data from other thorium systems shows that positive entropies of formation are atypical for binary intermetallic phases of thorium. The free energies of formation of the Th-Cu phases were found to be roughly one-half as negative as values reported for Zr-Cu phases at comparable temperatures and stoichiometries. (auth)

**28617** THERMODYNAMIC INTERPRETATION OF SYSTEMS WITH INTERMETALLIC COMPOUNDS. Moser, Z.; Fitzner, K. (Polish Academy of Sciences, Krakow). pp 379-391 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

The interpretation of systems with negative deviations from Raoult's law presents a number of difficulties, though such systems are frequently encountered in pyrometallurgical processes connected with nuclear reactor fuels. Experimental results are given for the Mg-Sn system with the mole fraction, $X_{Mg}$, varying between 0.03 and 0.35. An emf method based on concentration cells with a solid magnesium reference was employed. Results for the Mg-Sn system have been interpreted with Krupkowski's formalism, but this method is not suitable for interpretation of such systems as Mg-Bi or Mg-Sb, which contain more stable intermetallic compounds. For these systems therefore other methods were tested. It was shown that application of the quasi-ideal solution model assuming the formation of MgBi, $Mg_3Bi$ and MgSb, $Mg_3Sb$ results in good agreement with experimental data for magnesium in both the Mg-Bi and Mg-Sb systems and with the respective values of bismuth and antimony calculated by Gibbs-Duhem integration. (auth)

**28618** THERMODYNAMIC PROPERTIES OF THREE-COMPONENT γ-PHASE SOLID SOLUTIONS OF U WITH Zr, Nb, AND Mo. Fedorov, G. B.; Smirnov, E. A.; Gusev, V. N. (Moscow Engineering-Physics Inst.). pp 393-398 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In Russian).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

Using the emf technique, the thermodynamic activities of uranium in ternary gamma solid solutions of uranium and zirconium, niobium and molybdenum were measured. The emf from an electrochemical cell of the type $U_S \mid U^{3+} + (KCl\text{-}NaCl) \mid U_S$ (alloy) was measured over the temperature range 750 to 900°C. The alloys were prepared from electrolytic uranium, zirconium iodide, and from electron-beam melting of niobium and molybdenum in an arc furnace in a purified argon atmosphere. Uranium-rich alloys were studied in the radial cross-sections of a U-Zr-Nb system with Zr/Nb atomic ratios of 3, 1 and 1/3, and a U-Nb-Mo system with an Nb/Mo atomic ratio of 1. To plot lines of constant thermodynamic activity and excess free energy, the results of earlier studies on the thermodynamic properties of the binary systems U-Zr and U-Nb, and U-Mo were used. The thermodynamic activities of the components and the excess thermodynamic free energies of the ternary systems were determined by integrating the Gibbs-Duhem equations, based on Darken's method. In the same way as for ternary systems, negative deviations from the ideal state are observed. In the U-Zr-Nb system the predominant effect on this deviation is exerted by niobium, and in the case of the U-Nb-Mo system by molybdenum. (auth)

**28619** MASS-SPECTROMETRIC ANALYSIS OF THE THERMODYNAMIC PROPERTIES OF SOME SODIUM ALLOYS. Trouve, J. (CEN, Cadarache, France). pp 399-408 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975). (In French).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-308(Vol.2); CONF-741030-P2.

The use of a quadrupole-filter residual-gas analyzer and of

an ultra-vacuum pumping unit for obtaining thermodynamic data on liquid-vapor systems such as Na–I and Na–Cs is described. The apparatus and method used (Knudsen cell) as well as the first experiments performed with NaI, sodium, and a Na–5 at.% Cs alloys are also described. These experiments were used in each case to determine: the nature and composition of the vapor phase (monomeric and dimeric types) and the sublimation and vaporization heat. The monomeric (NaI) and dimeric ($Na_2I_2$) types of sodium iodide were investigated and their sublimation heats measured and found to be 43 kcal/mol and 46 kcal/mol, respectively. Assuming that the capture cross-section of the dimer is 1.5, the proportion of the latter is 4%. A vaporization heat of 23.5 kcal/mol and a dimer proportion of 1.5% were recorded for sodium at 330°C. The literature on the subject gives 24.5 kcal/mol and 2%, respectively. A vaporization heat of 17 kcal/mol for cesium and 23 kcal/mol for sodium were found in the case of a Na–5 at.% Cs alloy. In the next stage of the analysis twin cells will be used in order to determine directly the activity of each constituent in a metal alloy by making a comparison with the pressure above the pure metal. In practice a cell used with lithium and sodium has shown an interaction between the two holes of approximately 20%, which will make it necessary to align and focus the molecule beam more precisely. (auth)

**28620** CRYOGENIC HEAT CAPACITIES AND NEEL TRANSITIONS OF $UAs_2$ AND $USb_2$. Westrum, E. F. Jr. (Univ. of Michigan, Ann Arbor); Sommers, J. A.; Downie, D. B.; Groenvold, F. pp 409-418 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

The heat capacities of uranium diantimonide ($USb_2$) and uranium diarsenide ($UAs_2$) — with anti-$Cu_2Sb$ structures — have been measured by adiabatic calorimetry from 5 to above 700°K. Both heat capacity curves show sharp, lambda anomalies indicative of cooperative phenomena. The corresponding heat capacity maxima at 272.2 and 202.5°K for $UAs_2$ and $USb_2$, respectively, are related to maxima in respective magnetic susceptibility curves at 283 and 206°K, occasioned by transitions between antiferro- and paramagnetic states (Néel points). The heat capacities at 300 and 350°K (in $cal \cdot K^{-1} \cdot mol^{-1}$) are 19.11 and 19.18 for $UAs_2$, 19.16 and 19.33 for $USb_2$ (in comparison with 19.2 and 20.3 for (isostructural) $UP_2$ for which the Néel transition was found by Stalinski, et al. at 203°K). The differences in the temperature dependency and excess heat capacity between $UP_2$ and the others beyond the Dulong and Petit limit are especially pronounced even at 300°K. Lack of monotonic progression of Néel temperatures with anionic size may be due to the relatively small radius ratio in $UP_2$. Thermodynamic properties for both pnictides as well as the thermodynamics of the transitions have been evaluated. (auth)

**28621** HEAT CAPACITY OF UP FROM 80 TO 1080 K, AND THE ELECTRONIC CONTRIBUTION. Yokokawa, H.; Takahashi, Y.; Mukaibo, T. (Tokyo Univ.). pp 419-430 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

The heat capacity of uranium monophosphide from 80 to 1080°K was determined by an improved laser flash method. Below room temperature, the results agreed very well with those of Counsell et al., including the region of antiferroparamagnetic transition near 121 K. At higher temperatures, no sharp anomalous peak was observed up to 1080°K; a slight anomalous temperature dependence in heat capacity was found above room temperature. Thermodynamic functions of UP from 298 to 1050°K were calculated from the observed heat capacity and are tabulated. Attempts to resolve the observed heat capacity into various contributions are also reported. The lattice component of the heat capacity was estimated by the corresponding states method. The excess heat capacity, which was found to be high at all temperatures investigated, was analysed by following the localized $5f^2$ and $5f^3$ configuration models. (auth)

**28622** CALORIMETRIC STUDIES ON ACTINIDE COMPOUNDS AND MATERIALS OF INTEREST IN REACTOR TECHNOLOGY. O'Hare, P. A. G.; Ader, M.; Hubbard, W. N.; Johnson, G. K.; Settle, J. L. (Argonne National Lab., IL). pp 439-453 of Thermodynamics of Nuclear Materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.2); CONF-741030-P2.

Standard enthalpies of formation, DELTA H$^{\circ}$sub f/, at 298.15$^{0}$K, based on solution-reaction or fluorine bomb calorimetric measurements are reported for the following compounds: alpha-$Li_2UO_4$, $K_2UO_4$, $RbUO_4$, $Cs_2U_2O_7$, $Cs_2Mo_2O_7$, $Cs_2CrO_4$, $Li_3N$, $Li_2O$, $ThS_{1.029}$, $MoC_{0.502}$, $MoC_{0.651}$, $U_3Si$, and beta-$US_2$. The results are compared with earlier determinations and the significance of some of the data vis-a-vis the chemistry of processes in irradiated fuel pins is discussed. (auth)

**28623** SPECIAL PROPERTIES OF COPPER–BERYLLIUM ALLOYS. Albert, H. (Vacuumschmelze G.m.b.H., Hanau (F. R. Germany)). Metall; 28: No. 11, 1063-1067(Nov 1974). (In German).

21 figs.; 1 tab.; 10 refs.

Within the group of copper-base alloys, the group of precipitation hardening copper alloys is distinguished with a view to spring qualities and electric conductivity. These copper alloys obtain a favourable combination of properties as a result of precipitation hardening. The copper-beryllium alloys are especially preferred. Their special properties are outlined. (GE)

**28624** NON-STOICHIOMETRY AND MAGNETO-OPTIC PROPERTIES OF MAGNETIC BUBBLE THIN FILMS OF TmIG SUBSTITUTED WITH BISMUTH AND GALLIUM. Robertson, J. M.; Verplanke, J. C.; Wittekoek, S.; Bongers, P. F.; Jansen, M.; Op den Buis, A. (Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands). Forschungslaboratorium). Appl. Phys.; 6: No. 3, 353-356(1975).

Thulium iron garnet thin films substituted with bismuth and gallium were prepared by LPE from a $PbO \cdot B_2O_3$ flux. Radioactive isotope tracers were added to the melt as the chemical analysis technique. The deviation from the ratio (Pb + Bi + Tm)/(Fe + Ga) = 0.6 of the layers was large and a proportion of the thulium ions possibly lie on the octahedral crystallographic sites. The concentration of Bi, Pb, and Ga as function of the growth temperature was studied. The magneto-optic properties show that the layers are well suited for use in a magneto-optic device. A figure of merit of 2.5 degree per decibel at lambda = 560 nm was obtained and some magnetic bubble parameters are also presented. (auth)

**28625** MEASUREMENT OF THE MECHANICAL STATE OF A LOW ALLOY STEEL AT ELEVATED TEMPERATURE. Woodford, D. A. (General Electric Co., Schenectady, NY). Metall. Trans.; 6A: No. 9, 1693-1697(Sep 1975).

Load relaxation tests on a Cr–Mo–V steel are used to generate stress-strain rate curves at high temperature. It is shown that the mechanical state as described by these curves is sensitive to the deformation history, such that the alloy undergoes a hardening and subsequent softening as strain is accumulated. However, these changes are quite small in successive tests and it is shown that results at different temperatures can be made to coincide by a suitable translation of the strain rate scale at nearly constant mechanical state. The result is a stress-strain rate curve over about twelve orders of magnitude in strain rate so that initial creep rates at stresses far beyond the range covered at each temperature can be estimated. A previously proposed analytical expression for similar data on high purity aluminum fits the present data surprisingly well. From this expression a mechanical state, or hardness parameter, sigma*, is obtained. For any value of stress, the value of sigma* and its associated parameter, epsilon*, uniquely define the strain rate. (auth)

**28626** MICROSTRUCTURAL STUDIES OF A Ni–W DIRECTIONALLY SOLIDIFIED EUTECTIC COMPOSITE. Williams, J. C.; Garmong, G. (Rockwell International, Thousand Oaks, CA). Metall. Trans.; 6A: No. 9, 1699-1709(Sep 1975).

The influence of heat treatment on the microstructure of a Ni–45.5 wt percent W directionally solidified eutectic composite has been studied. Four types of microstructural conditions have been examined using light and thin foil electron microscopy techniques. The as-grown composite consists of W fibers in a matrix which contains some $WNi_4$ precipitates. Quenching the composite from above the peritectoid temperature results in W fibers in a Ni–W solid solution matrix. Subsequent aging results in precipitation of coherent $WNi_4$. Long time aging at temperatures just under the peritectoid temperature promotes the peritectoid reaction leading to envelopment of the W fibers by a layer of $WNi_4$. The envelopment reaction is accompanied by a change from faceted to round fiber morphology. The presence of W fibers in the Ni–W solid solution influences aging in two ways when compared to a solid solution alloy. First, the fiber/matrix interfaces act as dislocation sources on quenching; these dislocations are absorbed into the $WNi_4$ precipitate/matrix interfaces leading to early loss of coherency. Second, the $WNi_4$ precipitates undergo a preferential coarsening due to elastic interaction between the fibers and the $WNi_4$ precipitates; this leads to a mosaic structure, the occurrence of which is uniquely dependent on the presence of W fibers. (auth)

**28627** MONOTONIC AND FATIGUE DEFORMATION OF Ni–W DIRECTIONALLY SOLIDIFIED EUTECTIC. Garmong, G.; Williams, J. C. (Rockwell International, Thousands Oaks, CA). Metall. Trans.; 6A: No. 9, 1711-1719(Sep 1975).

Unlike many eutectic composites, the Ni–W eutectic exhibits extensive ductility by slip. Furthermore, its properties may be greatly varied by proper heat treatments. Results of studies of deformation in both monotonic and fatigue loading are reported. During monotonic deformation the fiber/matrix interface acts as a source of dislocations at low strains and an obstacle to matrix slip at higher strains. Deforming the quenched-plus-aged eutectic causes planar matrix slip, with the result that matrix slip bands create stress concentrations in the fibers at low strains. The aged eutectic reaches generally higher stress levels for comparable strains than does the as-quenched eutectic, and the failure strains decrease with increasing aging times. For the composites tested in fatigue, the aged eutectic has better high-stress fatigue resistance than the as-quenched material, but for low-stress, high-cycle fatigue their cycles to failure are nearly the same. However, both crack initiation and crack propagation are different in the two conditions, so the coincidence in high-cycle fatigue is probably fortuitous. The effect of matrix strength on composite performance is not simple, since changes in strength may be accompanied by alterations in slip modes and failure processes. (17 fig) (auth)

**28628** ASYMMETRICAL MECHANICAL BEHAVIOR OF A PRECIPITATION HARDENED BETA TITANIUM ALLOY. Tuominen, S. M. (Climax Molybdenum Co. of Michigan, Ann Arbor); Koss, D. A. Metall. Trans.; 6A: No. 9, 1737-1740 (Sep 1975).

Precipitation-hardened single crystals of a beta (bcc) Ti–40 at. percent V–1.0 at. percent Si alloy were deformed in compression at 77 and 298$^0$K. The dependence of the yield stress upon aging time at 843$^0$K for solution-treated crystals shows two maxima which are caused by silicide precipitates. The orientation dependence of the yield stress and of the active macroscopic slip plane were determined as a function of aging time. The solution-treated as well as aged crystals exhibit an asymmetry of both the yield stress and the plane of slip, the degree of asymmetry being larger at 77 than at 298$^0$K. The asymmetry of slip and yielding is not affected by the presence of precipitation hardening. Results indicate that the effect of the dislocation core structure on dislocation motion is independent of the presence of precipitates. (auth)

**28629** CREEP FRACTURE OF WROUGHT NICKEL-BASE ALLOYS BY A FRACTURE MECHANICS APPROACH. Floreen, S. (International Nickel Co., Sterling Forest, NY). Metall. Trans.; 6A: No. 9, 1741-1749(Sep 1975).

Creep fracture in the 500 to 750$^0$C temperature range was by an intergranular crack growth process involving the formation of microcracks in grain boundaries slightly ahead of the main crack. The crack growth was proportional to an exponential power of the stress intensity. Wide differences in cracking behavior were seen between different alloys, but their differences were due primarily to material processing history and not to composition per se. Transverse sample orientation and coarser grain sizes significantly improved the resistance to cracking. Both slow crack growth and the final fast fracture toughness changed appreciably with test history. A good correlation was found between the notch properties and the creep behavior of an unnotched sample loaded to the yield strength. (auth)

**28630** EFFECT OF THERMAL HISTORY ON THE AXIAL TENSILE BEHAVIOR OF AN ALIGNED FIBER COMPOSITE. Wakashima, K. (Tokyo Inst. of Technology); Kawakubo, T.; Umekawa, S. Metall. Trans.; 6A: No. 9, 1755-1760(Sep 1975).

The axial tensile behavior of an aligned tungsten fiber–copper composite has been studied in conjunction with plastic accommodation to thermal expansion mismatch. When the composite is subjected to a large change in temperature, the thermal expansion mismatch between matrix and fiber is accommodated by plastic deformation of the matrix. In contrast to the case of perfectly elastic accommodation (matrix and fiber both elastic), the composite undergoing plastic accommodation is in one of two distinct mechanical states at a given temperature, one of which is obtained on heating and the other on cooling. This results in that the subsequent tensile behavior of the composite is essentially dependent on the thermal history. A simple analysis based on three-dimensional continuum mechanics is presented to explain the observed phenomenon. (auth)

**28631** STRESS-INDUCED OMEGA PHASE TRANSFORMATION IN Ti–V ALLOYS. Kuan, T. S.; Ahrens, R. R.; Sass, S. L. (Cornell Univ., Ithaca, NY). Metall. Trans.; 6A: No. 9, 1767-1774(Sep 1975).

The deformation behavior of bcc (beta) Ti–V single crystals containing the athermal omega phase was studied using tensile tests, optical and electron microscopy, and x-ray and electron diffraction. The stress-strain curves were characterized by a marked yield point and an essentially zero work hardening rate. The deformation structures consisted of wavy slip and stress-induced plates. Both x-ray and electron diffraction showed that the stress-induced plates consist of one variant of the omega phase, with the orientation relation to the parent beta phase close to (0001)/sub omega/ parallel (001)/sub beta/; (11 anti 2 0)/ sub omega/ parallel (110)/sub beta/. The habit plane was of the type [554]. A small amount of alpha'(hcp) phase was present within the omega plate, with orientation relation to the beta phase close to the Burgers relationship i.e. (0001)/sub alpha prime/ parallel (110)/sub beta/; [11 anti 2 0]/sub alpha prime/ parallel [anti 1 11]/ sub beta/. It is suggested that the omega phase may be an intermediate structure in the stress-induced bcc yields hcp transformation. (auth)

**28632** IMPURITY SEGREGATION TO VOIDS IN DOPED TUNGSTEN RIBBON FILAMENTS. Walter, J. L.; Rao, P.; Russell, R. R. (General Electric Co., Schenectady, NY). Metall. Trans.; 6A: No. 9, 1775-1784(Sep 1975).

Filaments of Al-, Si-, and K-doped tungsten foil, 0.00254 cm thick, were heated to 2300$^0$C in vacuo until a hot spot developed. Within the hot spot were voids varying in size from about 50 to 6000 A. The larger voids were faceted with the major facets parallel to [110]. The relative surface tensions in the doped foil were in the order [110] less than [112] less than [111] less than [100] as determined from a model of the voids. Selected area diffraction showed that the void surfaces were coated with a thin epitaxial layer of potassium with [311]W parallel [311]K in the majority of cases. (auth)

**28633** EFFECT OF AGING ON THE MECHANICAL PROPERTIES OF A NICKEL–MOLYBDENUM–IRON ALLOY (HASTELLOY B). Der-Yan Frank Roan; Brooks, C. R. (Univ. of Tennessee, Knoxville). Metall. Trans.; 6A: No. 9, 1829-1831(Sep 1975).

Measurements of the tensile properties at 25 to 870$^0$C of solution-annealed Hastelloy B are reported with the 25$^0$C properties (hardness included) as functions of aging time (up to 1200 h) from 705 to 900$^0$C. Microstructures developed during the aging are also reported. The featherlike precipitates forming at 815 and 900$^0$C cause strengthening, but aging at 760 and 705$^0$C increases the strength even more, and this is associated with Widmannstatten precipitates. (DLC)

**28634** STRESS RELAXATION IN SOLUTION-ANNEALED AND 20 PERCENT COLD-WORKED TYPE 316 STAINLESS STEEL. Thomas, J. F. Jr. (Wright State Univ., Dayton, OH); Yaggee, F. L. Metall. Trans.; 6A: No. 9, 1835-1837(Sep 1975).

Relaxation experiments were conducted at room temperature and various levels of tensile plastic strain. The data for both solution-annealed (SA) and 20 percent cold-worked (CW) material can be presented in terms of a single family of nonintersecting hardness curves. Although the hardness curves for SA can be reduced to a master curve, those for CW fail to fit this master curve at strain rates below $5 \times 10^{-6}$ s$^{-1}$. The slope of the hardness scaling relation increases with plastic deformation. (DLC)

**28635** INFLUENCE OF THE CRYSTAL FIELD IN FERROMAGNETS. Druzhinin, V. V.; Zapasskii, S. P.; Povyshev, V. M. (Moscow Engineering Physics Inst.). Sov. Phys. - Solid State; 17: No. 1, 12-15(Jul 1975).

Translated from Fiz. Tverd. Tela; 17: No. 1, 23-29(Jan 1975).

The molecular field approximation is used to calculate the magnetization and the equilibrium orientation of the magnetic moment of a ferromagnet in a crystal field of an arbitrary magnitude. The crystal field parameters are fitted to obtain the angles between the magnetic moment and the hexagonal axis for rare earth metals Tb, Dy, Ho, Er, and Tm. For these values of the parameters, the temperature dependence of the magnetization of Tb is obtained in fields of 3 and 18 kOe and compared with the experimental results. For an anisotropy $-AJ_z^2$, the shift of the Curie temperature from its isotropic value is calculated for J = 1, $\frac{5}{2}$, 5, 6, 8; the spontaneous magnetization is obtained for J = 5, 8 and for positive and negative values of A. (auth)

**28636** MAGNETOPHONON RESONANCE IN N-TYPE InSb. Amirkhanov, Kh. I.; Bashirov, R. I.; Elizarov, V. A. (Inst. of Physics, Makhachkala, USSR). Sov. Phys. - Solid State; 17: No. 1, 230-231(Jul 1975).

Translated from Fiz. Tverd. Tela; 17: No. 1, 361-363(Jan 1975).

The second derivative of the magnetoresistance of indium antimonide samples with a mobility $u = 510{,}000$ cm$^2 \cdot$V$^{-1} \cdot$s$^{-1}$ and $n = 1.8 \cdot 10^{14}$ cm$^{-3}$ (77°K) in magnetic fields up to 37 kOe was

measured. The experimental results are presented in plots. The transverse magnetoresistance curve had—in addition to the seven maxima reported by Stradling and Wood—four further main maxima and, therefore, the number of the experimentally observed main maxima reached 11. The series of the main transverse magnetoresistance maxima observed at 77°K was located at the following values of the magnetic field $H_{max}$: 34, 16.4, 10.8 8.05, 6.35, 5.35, 4.45, 3.85, 3.35, 3.00, and 2.70 kOe. Additionally, three much weaker maxima: $a_1$ at 21.4, $a_2$ at 19.7, and $a_3$ at 14.2 kOe were found. The longitudinal magnetoresistance recorded at liquid-nitrogen temperature had nine main minima at the following fields $H_{min}$: 34, 16.3, 10.7, 8.00, 6.30, 5.25, 4.50, 3.75, and 3.40 kOe as well as two other main minima (10th and 11th) which appeared only at 120°K: $H_{min}$ = 2.5 and 2.1 kOe. The additional minima $a_1$, $a_2$, and $a_3$ of the longitudinal resistance were located at 21.5, 19.5, and 14.0 kOe (77°K). At higher temperatures a series of minima $b_1$–$b_4$, located at the following values of the magnetic field $H_{min}$: 24, 12.5, 8.5, and 6.75 kOe (T = 160°K) were observed. (auth)

**28637** STUDIES ON STRUCTURAL STABILITY AND CREEP STRENGTH DEPENDING ON TIME OF THE ALLOY NIMONIC 81. Erdoes, E.; Friedl, K. H.; Rosselet, A. (Sulzer Bros. Ltd., Winterthur (Switzerland). Abt. Forschung und Entwicklung; Brown, Boveri and Co. Ltd., Baden (Switzerland)). Metall; 29: No. 1, 33-38(Jan 1975). (In German).

15 figs.; 3 tabs.; 9 refs.

Metallographic studies with gas turbine blades from operation and creep-rupture tests showed that nimonic 81 tends to precipitate elementary chromium in needle and flake shape at a temperature of 650 to 750°C after a time > 2,000 hr. These precipitations are accompanied by a reduced fracture strain and a slight fatigue notch sensitivity in the creep-rupture test after about 5,000 hr. (auth)

**28638** X-RAY DIFFRACTION STUDY OF THE ALLOYS OF THE TERNARY SYSTEMS Al–Zr–(La, Ce, Pr, Nd) RICH IN ALUMINUM. Tivanchuk, G. T. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 7, 660-661(Jul 1975). (In Ukrainian).

The ternary Al–Zr–{La, Ce, Pr, Nd} systems in the region of 66.7–100 at.% Al were investigated by x-ray powder diffraction analysis. No ternary compounds and solid solutions based on the binary compounds were found within the studied ranges. Results are presented as corresponding isothermal sections at 500°C. (auth)

**28639** STRUCTURE OF THE COMPOUNDS HfCuSi. Andrukhiv, L. S.; Lysenko, L. O.; Yarmolyuk, Ya. P.; Hladyshevsky, E. I. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 7, 645-648(Jul 1975). (In Ukrainian).

The crystal structure of 4 isostructural compounds: $HfCuSi_2$ (a = 3.732; c = 8.99 Å), $HfCuGe_2$ (a = 3.745, c = 9.02 Å), $ZrCuSi_2$ (a = 3.719, c = 9.01 Å), $ZrCuGe_2$ (a = 3.787, c = 9.12 Å) was determined by means of the x-ray powder method. The tetragonal unit cell of the $HfCuSi_2$ structure contains 8 atoms in the following positions of the space group P4/nmm: 2 Hf in 2(c) ¼ ¼ z, z = 0.741, 2Cu in 2(a) ¾ ¼ 0; $2Si^{(1)}$ in 2(c) ¼ ¼ z, z = 0.189, $2Si^{(2)}$ in 2(b) ¾ ¼ ½. The coordination polyhedra of Hf and Cu are deformed cubooctahedra (c.n. 12), $Si^{(1)}$—a tetragonal antiprism, $Si^{(2)}$—eight-cornered polyhedron. The structure of $HfCuSi_2$ is related to the $CeGa_2Al_2$, PbFCl, and $CaF_2$ types. (auth)

**28640** USE OF HIGH RESOLUTION MASS SPECTROMETRY IN THE MEASUREMENT OF THERMODYNAMIC PROPERTIES OF METALLIC SYSTEMS. Moore, R. H.; Robinson, D.; Argent, B. B. (Univ. of Sheffield, Eng.). J. Phys., E (London); 8: No. 8, 641-648(Aug 1975).

From international conference on metallurgical chemistry; London, England (Aug 1975).

An experimental technique is described for the use of high resolution mass spectrometry in the determination of activities and heats of sublimation. It is shown that experimental difficulties due to the interaction of permanent gases (CO, Ar, $N_2$, $H_2$ and He) with metal vapors (Fe, Co, Cr, V) can be overcome. Second law heats of sublimation are given for vanadium, chromium, iron, and cobalt which agree with literature values obtained by different methods. (auth)

**28641** MOESSBAUER SPECTROSCOPIC STUDIES ON SUPERSATURATED GOLD–IRON MIXED CRYSTALS. Nagorny, K.; Sola, F. (Hamburg Univ. (F. R. Germany). Inst. fuer Physikalische Chemie). Z. Phys. Chem. (Frankfurt); 92: No. 1-3, 125-138 (Sep 1974). (In German).

8 figs.; 14 refs.

From the Moessbauer spectra of gold-iron mixed crystals of different composition (1 to 45 at.% iron) it can be deduced that the iron atoms undergo interactions of different kinds in the gold matrix. Homogeneous mixed crystals in the concentration range of 1 to 25 at.% iron show Moessbauer spectra from separate iron atoms which are in quadrupole interaction with other iron atoms. In the concentration range of 25 to 33 at.% iron, the formation of a spontaneous magnetized phase can be observed. At 35 at.% iron contents, this phase is distinctly recognizable by a sextet which differs essentially from that of α-iron. Results of high temperature measurements lead to the conclusion that the Curie point of these magnetic phases is lower than that of α-iron. These spectra are compared with those of the homogeneous samples. As expected from the phase diagram, measurements on supersaturated mixed crystals show the precipitation of α-iron. (auth)

**28642** PARAMAGNETIC RESONANCE OF Er AND Dy IN $ScAl_2$. Devine, R. A. B. (Univ., Montreal); Poirier, M.; Cyr, T. J. Phys., F. (London); 5: No. 7, 1407-1416(Jul 1975).

Paramagnetic resonance measurements were made on Er and Dy in $ScAl_2$; the ground states are in both cases $\Gamma_7$ doublets. The temperature dependence of the linewidth shows that the exchange parameters are equal within experimental error. It is shown that in general g shift and linewidth measurements are insufficient to enable absolute deduction of the exchange parameters. A tentative explanation of the role of conduction electrons in creating the crystal field in Laves phase di-aluminide compounds is given. (auth)

**28643** POSITRON ANNIHILATION AND ELECTRON CORRELATIONS IN METALS. Lowy, D. N.; Jackson, A. D. (State Univ. of New York, Stony Brook). Phys. Rev., B; 12: No. 5, 1689-1706(1 Sep 1975).

The annihilation rate of positrons in metals can be related to the correlated electron wave function at the positron site. It is argued that the effective interaction at short distance for a positron in an electron gas should be dominated by terms involving one and two electrons. The positron-electron wave function is thus calculated using an effective interaction which includes the strong screening effects from one highly correlated screening electron. The electron wave functions are approximately antisymmetrized using the analogy of a recoilless impurity. The positron annihilation rates calculated using this wave function are in good agreement with the observed rates over the whole range of electron densities found in alkali metals. (auth)

**28644** NEUTRON-DIFFRACTION STUDY OF FERRIMAGNETIC $DyCo_3$. Yakinthos, J. K.; Mentzafos, D. E. (Democritos Nuclear Research Center, Athens). Phys. Rev., B; 5: No. 5, 1928-1932(1 Sep 1975).

$DyCo_3$ was found to be ferrimagnetic with cobalt moments antiparallel to the dysprosium moments. At 80 and 300°K, the easy-magnetization axis is perpendicular to the hexagonal c axis; at 400°K the moments are parallel to c. Experimental data and crystal-field calculations, based on the point-charge model, are in agreement under the assumption that the two different crystallographic sites of dysprosium have anisotropy directions perpendicular to each other. (auth)

**28645** CRITICAL SMALL-ANGLE X-RAY SCATTERING OF THE LIQUID SODIUM–LITHIUM SYSTEM. Wu, E. S.; Brumberger, H. (Syracuse Univ., N. Y. (USA). Dept. of Chemistry). Phys. Lett., A; 53: No. 6, 475-477(28 Jul 1975).

Small angle x-ray scattering of the liquid sodium–37 wt% lithium system in the range $1.034 \times 10^{-4} \leq (T - T_c)/T_c \leq 1.503 \times 10^{-2}$ yields the critical exponents $\nu = 0.655 \pm 0.030$ and $\gamma = 1.296 \pm 0.061$ for the temperature dependence of the correlation length $\xi$ and of the coefficient $(\partial c/\partial \mu)_{T,P}$ respectively. (auth)

**28646** MAGNETIC MEASUREMENTS ON DILUTE MONOCRYSTALLINE MgNd. Burr, C. R.; Pirich, R. G. (Department of Physics, State University of New York at Binghamton, Binghamton, New York 13901, USA). Phys. Lett., A; 53: No. 6, 449-450(28 Jul 1975).

Dilute Mg–Nd alloys show anisotropy in magnetic susceptibility below 50°K due to the crystalline electric field of Mg. A fit to the data by minimizing chi-square indicates a splitting of the $^4I_{\frac{9}{2}}$ ground state of $Nd^{+3}$ of 75°K. (auth)

**28647** SPECIFIC HEAT OF Pd–Gd 6 AT.%. Zweers, H. A.; van der Linden, H. W. M.; Nieuwenhus, G. J. (Rijksuniversiteit Leiden (Netherlands). Kamerlingh Onnes Lab.). Physica; 79: No. 1, 83-85(Jan 1975).

Results for the specific heat of Pd–Gd 6 at.% alloy are presented. For a homogeneous alloy a sharp magnetic transition was found. (auth)

**28648** A TRANSIENT CREEP SOLUTION FOR UNIAXIAL TENSION RECTANGULAR THIN PLATES WITH CENTRAL CIRCULAR HOLES. Hata, T. (Shizuoka Univ. (Japan)). Nucl. Eng. Des.; 32: No. 3, 325-336(1975).

A general method for the solution of non-linear creep problems

is presented. This method reduces the creep problem to a sequence of elastic problems with initial strains. The solution of the elastic problem with initial strains is determined using four displacement functions together with the point-matching method. The method is based on the extension of Goodier's concept of reducing a thermoelastic problem to one at constant temperature with no body force. Using this method, creep behavior in the vicinity of a circular hole in a uniaxial tension thin rectangular plate was investigated for a time-hardening material law. The results show how stress concentration factors vary with time for various combinations of geometrical shape and stress index. (auth)

**28649** TRANSVERSE SHEAR EFFECT IN A BIMODULUS PLATE. Kamiya, N. (Mie Univ., Tsu (Japan). Faculty of Engineering). Nucl. Eng. Des.; 32: No. 3, 351-357(1975).

Bending analysis of a bimodulus elastic plate whose stress-strain relation is expressed by two straight lines with a slope discontinuity at the origin is considered. An energy formulation of the problem is made, taking into account a transverse shear deformation. A method of numerical solution is presented for cylindrical bending of a plate. (auth)

**28650** THE EFFECT OF INTERNAL PRESSURE ON THE CREEP RELAXATION OF A THIN, STRAIGHT LINE. Boyle, J.; Spence, J. (Strathclyde Univ., Glasgow (UK). Dept. of Mechanics of Materials). Nucl. Eng. Des.; 32: No. 3, 382-385(1975).

The effect of constant internal pressure on the relaxation of bending moment on a long, thin, circular cross section cylindrical shell is determined. The inadequacy of several simple approximate analyses, previously proven useful in other creep applications, is established. (auth)

**28651** EXCITATION OF SURFACE PLASMONS BY ELECTRONS IN A PARABOLIC BEAM. Gumhalter, B.; Newns, D. M. (Imperial Coll. of Science and Technology, London (UK)). Surf. Sci.; 50: No. 2, 465-478(Jun 1975).

A theory is presented for the excitation of surface plasmons by an electron beam following a non-touching path above a metal surface in Born approximation. The metal is assumed to possess only surface plasmon excitations. Configurations involving deflection of the electron beam in a parallel plate condensor, and by scattering from a field emission tip are envisaged. The relation between experimental conditions and the validity of the semi-classical approximation is discussed. The region of space above the surface in which scattering occurs is calculated, but the feasibility of the experiment depends on electron optical factors that are outlined. (auth)

## Radiation Effects

*Refer also to abstracts 27662 and 30212.*

**28652** (BNWL-1901(Vol.1)) STATE OF THE ART REVIEW OF DEGRADATION PROCESSES IN LMFBR MATERIALS, Volume I, Mechanical Properties. Dillon, R. D. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 7 Mar 1975. Contract E(45-1)-1830. 475p. Dep. NTIS $26.75.

A LMFBR materials degradation summary is presented in a format compatible with periodic up-dating. Information is presented in sections on swelling, radiation effects on tensile properties, radiation effects on high strain-rate properties, radiation effects on creep-rupture properties, radiation effects on fatigue, radiation effects on welds, fuel-clad interactions, and effects of Na on reactor materials. (JRD)

**28653** (CONF-751006-4) DEPTH DISTRIBUTION OF DAMAGE IN COPPER IRRADIATED WITH MeV, Ni AND He IONS. Narayan, J.; Noggle, T. S.; Oen, O. S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 10p. Dep. NTIS $4.00.

From international conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

Transmission electron microscopy was used to study radiation damage as a function of depth caused by 58 and 4-MeV $^{58}$Ni and 1-MeV He ions in copper single crystals at ambient temperature. The experimental damage density vs penetration depth distributions were compared with calculations based on the atomic collision theory of Lindhard et al. (LSS). For 58-MeV Ni ions, the calculated damage profile using the theoretical LSS value of the electronic stopping parameter (k equals 0.167) agrees well with experiment. However, for 4-MeV Ni ions it is necessary to use k equals 0.12 to get agreement with the experimental data. In the case of 1-MeV He, the depth location of the calculated damage peak is in good agreement with experiment when the electronic stopping determined by Chu and Powers is used whereas it is about 15 percent too close to the surface using the tables of Northcliffe and Schilling. (auth)

**28654** (CONF-751006-6) RECOVERY IN STAGES I AND II OF THERMAL AND FISSION NEUTRON IRRADIATED MOLYBDENUM. Coltman, R. R. Jr.; Klabunde, C. E.; Redman, J. K. (Oak Ridge National Lab., Tenn. (USA)). 1975. 7p. Dep. NTIS $4.00.

From international conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

The influence of initial dose and irradiation doping upon the recovery of Mo was studied for the markedly different types of damage produced by thermal and fission neutrons. The features of the Stage I recovery commonly seen for several fcc metals can be identified, including a I/sub D/ peak at 40$^0$K. The typical dose-dependent behavior of a I/sub E/ subpeak was observed at approximately 47$^0$K, and evidence for free interstitial migration is further supported by irradiation doping results. Stage II shows a first-order peak at 120$^0$K in which the population percentage increases with increasing initial dose in opposite fashion to fcc impurity detrapping peaks. (auth)

**28655** (COO-2119-15) EXPERIMENTS IN HIGH VOLTAGE ELECTRON MICROSCOPY. Progress Report, October 31, 1974–July 1975. Mitchell, T. E.; Das, G.; Barnard, R.; Ro, D. (Case Western Reserve Univ., Cleveland, Ohio (USA). Dept. of Metallurgy and Materials Science). 1975. Contract AT(11-1)-2119. 14p. Dep. NTIS $4.00.

High voltage electron microscopy (HVEM) was used for studies of irradiation damage in a variety of materials. Threshold displacement energies were determined for a fcc metal (copper) and a bcc metal (vanadium). The directions for minimum displacement were correlated with the crystal structure. The threshold energy is approximately 4 to 5 times the sublimation energy. The conditions for the formation of loops and voids were investigated. Results are presented for copper, nickel, stainless steel, and vanadium. The effects of electron irradiation on precipitation in Al–3.5 percent Cu were investigated. Results are also presented for an Al–Si alloy and stainless steel. Results on electron irradiation damage in ceramic oxides (quartz, alumina and magnesia) were also obtained. In quartz, displacement damage causes loop formation but the main effect is the destruction of crystallinity by ionization damage. In $Al_2O_3$ and MgO, only displacement damage was observable and threshold energies were determined. High temperature irradiation gives rise to faulted and multi-layer loops on the basal plane in $Al_2O_3$, and perfect loops on the (110) planes in MgO. (auth)

**28656** (HEDL-SA-653) IRRADIATION-INDUCED SWELLING VARIATIONS RESULTING FROM COMPOSITIONAL MODIFICATIONS OF 316 STAINLESS STEEL. Bates, J. F. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1974. Contract E(45-1)-2170. 31p. (CONF-740651-6). Dep. NTIS $4.75.

From symposium on the effects of radiation on structural materials; Gatlinburg, Tennessee, USA (11 Jun 1974).

The irradiation-induced swelling of 316 stainless steel is shown to be strongly dependent upon minor alloying constituents. At fluences around 2-4 x 10$^{22}$ n/cm$^2$ (E greater than 0.1 MeV), increasing the levels of concentration of C, P, and Si was found to be most effective in increasing the swelling resistance of the alloy system. The Mn content was found to exhibit a less pronounced effect on the swelling than C, P, or Si variations. Variations in S, N, and B showed no significant effect on swelling. Mo and Co variations resulted in quite anomalous swelling behavior, but the data did suggest that increases in these elements in 316 stainless steel would, in some cases, reduce the swelling. Cr and Ni variations resulted in data which suggested trends but was inconclusive. All of the results indicate a temperature dependence. Quantification of these effects is possible through a model which empirically relates alloy composition to the fluence at which steady-state swelling begins. (12 fig) (auth)

**28657** (IS-T-690) RADIATION DAMAGE IN VANADIUM DOPED WITH OXYGEN. Bajaj, R. (Ames Lab., Iowa (USA)). Oct 1975. Contract W-7405-eng-82. 228p. Dep. NTIS $14.50.

Thesis.

Damage caused by neutron irradiation was studied in vanadium containing various amounts of oxygen by transmission electron microscopy, tensile testing, and hardness measurements. It was found that the observed radiation-anneal hardening was caused by trapping of oxygen at the radiation-produced defect clusters. Similar behavior was exhibited by measurements of microhardness. Radiation-produced defect clusters were studied by transmission electron microscopy in as-irradiated and post-irradiation-annealed single crystal vanadium irradiated to a dose of 1.4 x 10$^{19}$ n/cm$^2$ (E greater than 1 MeV) at 95$^0$C. The number density of defect clusters increases with increasing oxygen content and the average size decreases with increasing oxygen content. Dislocation channels were observed by transmission electron microscopy in as-

irradiated and post-irradiation-annealed specimens deformed at room temperature, irrespective of oxygen content. The mechanism of channeling formation is still uncertain. However, the mechanism involving annealing of defect clusters by heat of plastic deformation appears plausible. (auth)

**28658** (SAND-75-5430) ANNEALING OF DISLOCATION LOOPS IN NEUTRON-IRRADIATED COPPER INVESTIGATED BY POSITRON ANNIHILATION. Gauster, W. B.; Mantl, S.; Schober, T.; Triftshauser, W. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung; Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 7p. (CONF-751006-2). Dep. NTIS $4.00.

From international conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

Positron annihilation angular correlation measurements were carried out on neutron-irradiated copper as a function of annealing temperature. Two types of specimens were used: single crystals irradiated with fast neutrons, and $^{10}B$-doped polycrystalline samples irradiated with thermal neutrons. All irradiations were at approximately 320°K. A structure in the annealing curve, not previously observed by other techniques, indicates that between 460 and 600°K the dislocation loops present after irradiation dissociate and more effective positron trapping sites are formed. (auth)

**28659** (SAND-75-5515) IMPLANTATION METALLURGY. Picraux, S. T. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 24p. (CONF-750926-4). Dep. NTIS $4.25.

From international conference on applications of ion beams to materials; Warwick, UK (9 Sep 1975).

Important changes in the near-surface physical properties of metals were obtained by high-fluence ion implantation. Recently there have been an increasing number of studies of the behavior of implanted species with the aim of understanding the detailed physical processes that occur in an implanted metal layer. A key aspect of these implantation metallurgy studies has been the ability to form uniquely controlled systems in the near-surface regions of metals that can be studied with accurate depth resolution. Metallurgical parameters that may be difficult or impossible to obtain by other means can be measured. Also, parameters that depend on the implantation process, due to the athermal introduction of atoms and defects can be determined. Thus the dual objective of implantation metallurgy is to obtain information to improve understanding of the microscopic aspects of metallurgy and to understand how to form controlled new metallurgical systems. Examples of parameters studied include implanted impurity location, diffusion, enhanced diffusion, solubility, precipitation, and dissolution. (auth)

**28660** (SAND-75-5516) ION CHANNELING STUDIES OF THE LATTICE LOCATION OF INTERSTITIAL IMPURITIES: HYDROGEN IN METALS. Picraux, S. T. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 10p. (CONF-750949-3). Dep. NTIS $4.00.

From international conference on ion beam surface layer analysis; Karlsruhe, F.R. Germany (15 Sep 1975).

The ability to detect distortions of interstitial impurities away from high symmetry sites by the channeling technique was examined for axial channeling. Multi-row continuum calculations of the angular distributions as a function of displacement from the center of the channel and increased impurity vibrational amplitude suggest localization of interstitials can be made to less than or equal to 0.4 A from flux peaking structure and less than or equal to 0.2 A when projections can be found which give appreciable dips (greater than or equal to 20 percent). Experimental examples are given for deuterium interpreted from channeling measurements to be located near the tetrahedral interstitial site in W and in distorted near-octahedral interstitial sites in Cr and Mo. Calculated and measured broken bracket 100 broken bracket angular distributions for these sites show good agreement. (auth)

**28661** (SAND-75-5519) PHYSICAL STATE OF IMPLANTED W IN COPPER. Borders, J. A.; Cullis, A. G.; Poate, J. M. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. 14p. (CONF-750926-3). Dep. NTIS $4.00.

From international conference on applications of ion beams to materials; Warwick, UK (9 Sep 1975).

Transmission electron microscopy and $^4He$ ion channeling measurements were combined to investigate the physical state of implanted W in copper. For 60°K implantations of $2 \times 10^{15}$ W cm$^{-2}$, W is found to be 100 percent substitutional and is still 90 percent substitutional for a dose of $10^{16}$ W cm$^{-2}$. Implantation of $10^{17}$ W cm$^{-2}$ produces a thin disordered surface layer of W and Cu with the W occupying no regular lattice site. On annealing to 600°C, W precipitates are formed with dimensions of a few hundred A and certain preferred orientations in the Cu lattice. (auth)

**28662** ELECTRON IRRADIATION DAMAGE IN COPPER AND VANADIUM. Kenik, E. A. Cleveland; Case Western Reserve Univ. (1974). 168p. University Microfilms Order No. 75-19,219. Thesis (Ph. D.).

Electron irradiation damage studies were performed on thin foils of pure copper and uhv outgassed vanadium in a high-voltage electron microscope. Threshold energies in both metals were determined for the three primary directions from the accelerating voltage required for the formation of visible clusters. Significant subthreshold damage was observed in copper for (100) and (111) irradiations. This damage was attributed to a series collision mechanism involving interstitial hydrogen. Identification and analysis of the defect clusters formed during irradiation were performed. In copper, both small and large dislocation loops were identified as interstitial Frank loops. The effects of foil thickness, electron flux, temperature, and deformation on the formation of voids were investigated. Dislocations were shown to play two different roles in void formation and the associated swelling. First, dislocation biasing is required for void formation and as such, as dislocation density is increased initially, swelling is enhanced as a result of higher biasing. However, as the dislocation density continues to increase with deformation, suppression of swelling occurs, as dislocation tangling reduces the biasing and the vacancy concentration is reduced by loss of vacancies to dislocations. (Diss. Abstr. Int., B)

**28663** RADIATION ENHANCED PRECIPITATION IN Al–4 PERCENT Cu BY HIGH VOLTAGE ELECTRON MICROSCOPY. Sklad, P. S. Cleveland; Case Western Reserve Univ. (1975). 128p. University Microfilms Order No. 75-19,247. Thesis (Ph. D.).

Effect of electron irradiation on the precipitation behavior of an Al–4 percent Cu alloy was investigated using high-voltage electron microscopy. High-flux irradiation at room temperature produced interstitial dislocation loops in both solution-treated specimens and aged specimens. Behavior of these loops is consistent with that of similar loops in pure Al. The irradiation also reduced the number of G.P. zones present. This effect is discussed in terms of: (a) the instability which occurs when vacancies necessary for the formation of the zones are annihilated by irradiation-produced interstitials, (b) the disordering of the zones by the "mixing" action of the irradiation, or (c) a decrease in the stability of zones which accompanies the irradiation enhanced appearance of the more stable theta' phase. Electron irradiation also inhibited the formation of the metastable theta'' phase in solution-treated specimens and to cause existing theta'' precipitates in aged specimens to disappear in favor of theta' precipitates. The mechanism responsible may be related to a change in the stability of theta'' resulting from the presence of large numbers of irradiation-produced defects or to the "mixing" action of the irradiation. Enhancement of theta' precipitation was observed to be primarily due to enhanced diffusion. Analysis of the measured growth rate demonstrated that the enhanced diffusion coefficient responsible for the precipitation of theta' is independent of temperature up to a temperature of approximately 150°C and is in agreement with theoretical predictions for the case where irradiation-produced defects are lost by migration to fixed sinks, i.e., precipitates. Above 150°C, there is a smaller enhancement until normal thermal aging is reached at approximately 250°C. (Diss. Abstr. Int., B)

**28664** IMPROVEMENTS IN OR RELATING TO METHODS FOR TREATING STEEL TO MODIFY THE STRUCTURE THEREOF. Nelson, R. S.; Mazey, D. J.; Hudson, J. A. (to United Kingdom Atomic Energy Authority). British Patent 1,392,811/B/. 30 Apr 1975. 2p.

The normal case hardening process for steel involves subjecting the metal to high temperatures in an atmosphere rich in C. With some steels, for example stainless steel, this may be undesirable, and the object of the method described is to provide a process for hardening stainless steel not involving high temperatures. The surface is bombarded with C ions of energy appropriate to ion implantation. The depth to which ions are implanted depends on their energy and the depth of penetration may be such that a hardened structure may be formed within a body below the surface. It is also possible to implant at different energies so as to build up a series of implanted regions. Implantation may be carried out from low energies up to energies of several thousand keV. It is possible by this method to produce hardened regions in stainless steel articles previously fabricated to high precision, since the risk of distortion and loss of precision arising from subjecting the articles to high temperatures is obviated. Examples of application of the method are given. (UK)

**28665** IMPROVEMENTS IN OR RELATING TO METHODS FOR TREATING STEEL TO MODIFY THE STRUCTURE THEREOF. Nelson, R. S.; Mazey, D. J.; Hudson, J. A. (To United Kingdom

Atomic Energy Authority). British Patent 1,392,812/B/. 30 Apr 1975. 2p.

A method is described for treating mild steel so as to increase the corrosion resistance of its surface. The surface is bombarded with Cr ions of energy appropriate to ion implantation. The depth to which the ions are implanted depends on their energy and the depth of penetration may be such that a resistant structure may be formed within the metal below the surface. The outer region can then be removed by mechanical means such as abrading, grinding, etc. It is also possible to implant at different energies so as to build up a series of implanted regions. Implantation may be carried out from low energies up to energies of several thousand keV. Energies in the range 50 to 100 keV are normally convenient. This low temperature method possesses important advantages over methods involving the use of high temperatures. It is possible to produce regions of increased corrosion resistance on mild steel articles previously fabricated to high precision, since the risk of distortion and loss of precision arising from subjecting the articles to high temperatures is obviated. Examples of application of the method are given. (UK)

**28666** RADIATION RESISTANCE OF MARAGING STEEL. Zot'ev, Yu. A.; Kagan, E. S.; Fedortsov-Lutikov, G. P.; Vishkarev, O. M.; Shamardin, V. K. Met. Sci. Heat Treat.; 16: No. 9-10, 860-861(1974).

Translated from Metalloved. Term. Obrab. Metal.; 16: No. 10, 43-45(Oct 1974).

The radiation resistance of maraging steels is superior to that of pearlitic steels. After irradiation with an integral neutron flux of $8.10^{20}$ n/cm$^2$ at 70-100°, the ductile-brittle transition temperature of the pearlitic steel rises from -80 to +100°, while that of the maraging steel remains below -80°. The changes in the strength, ductility, and toughness are smaller than in pearlitic steels. The radiation resistance of maraging steel increases with the original strength after heat treatment and with the concentration of alloying elements, causing an increase in strength during aging. (auth)

**28667** INFLUENCE OF IRRADIATION TEMPERATURE (4.2 AND 77°K) ON THE RESISTIVITY RECOVERY OF PURE AND Ge ALLOYED ALUMINIUM. Kontoleon, N.; Papathanassopoulos, K.; Chountas, K. (Democritus Nuclear Research Center, Athens (Greece)). Phys. Lett., A; 53: No. 5, 413-414 (14 Jul 1975).

An examination of the resistivity increment of pure and Ge alloyed aluminum neutron irradiated at 77 and 4.6°K followed by an anneal at 77°K was carried out. In the first treatment, the resistivity increment, for pure and germanium alloyed aluminum, was found smaller than that corresponding to the second treatment. (auth)

**28668** CORRELATION BETWEEN SWELLING AND ANNIHILATION LINESHAPE PARAMETER IN NEUTRON-IRRADIATED MOLYBDENUM. Cheng, L. J.; Sen, P. (State Univ. of New York, Albany (USA). Dept. of Physics). Phys. Lett., A; 53: No. 5, 417-418(14 Jul 1975).

A correlation between the swelling phenomenon and the change in the positron annihilation lineshape parameter ($\Delta S$) in neutron-irradiated molybdenum was observed. The observation of the minimum in $\Delta S$ for 400°C irradiation shows clearly that the majority of vacancy defects created during irradiations at $T < 400$°C differs from that formed during irradiations at $T > 400$°C. For the same neutron fluence, the concentration of vacancies created at 350°C is much larger than that of voids formed at 450°C and is also indicated by the observation of smaller swelling in samples irradiated at 450°C. The larger change in $\Delta S$ observed for the samples irradiated at 450°C suggests that the defects responsible for the change are much larger than those in samples irradiated at 350°C. (auth)

**28669** NEW EVIDENCE OF POSITRONIUM FORMATION IN NEUTRON-IRRADIATED MOLYBDENUM CRYSTAL CONTAINING VOIDS. Sen, P.; Cheng, L. J. (State Univ. of New York, Albany (USA). Dept. of Physics); Kissinger, H. E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Phys. Lett., A; 53: No. 4, 299-300(30 Jun 1975).

New evidence for the presence of positronium atom in neutron-irradiated molybdenum crystal containing voids was observed. A negative positronium work function for molybdenum has been indicated. (auth)

**28670** MAGNETIC HYPERFINE FIELDS AT Ta IN Co AND Fe HOSTS MEASURED BY THE $e^-$-$\gamma$ TIME-DIFFERENTIAL PERTURBED-ANGULAR-CORRELATION METHOD. Soares, J. C.; Krien, K.; Freitag, K. (Bonn Univ. (F. R. Germany). Inst. fuer Strahlen- und Kernphysik). Hyperfine Interactions; 1: No. 1, 45-53(Jun 1975).

The radionuclide $^{181}$Hf was implanted into pure Co and Fe hosts with the help of an isotope separator. The ferromagnetic hosts produce very strong magnetic hyperfine interactions at the nuclear site of Ta atoms. These hyperfine interactions were studied by time-differential measurements of the 133 keV conversion electron-482 keV $\gamma$ angular correlation. It is found that in both hosts an appreciable fraction of Hf atoms occupies regular lattice sites after the implantation. Using the known g-factor of the 482 keV state of $^{181}$Ta the magnetic hyperfine fields $H_{hf} = \pm 362.4(5.0)$ and $\pm 596(18)$ kG for the Co and Fe hosts, respectively, were deduced. These fields fit nicely into the systematics of the hyperfine fields for the 5d transition elements but are not well accounted by the existing theoretical models. (auth)

**28671** CRITIQUE OF THE UNSATURABLE TRAP MODEL OF RADIATION DAMAGE IN METALS. Frank, W.; Seeger, A. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Radiat. Eff.; 25: No. 1, 17-26(1975).

The unsaturable trap model, which attributes the increase of the electrical resistivity of fcc metals during electron irradiation in the temperature regime of Stage-II recovery to the trapping of Stage-$I_E$ interstitials at impurity atoms, is shown to be in serious disagreement with experiments. Predictions of the unsaturable trap model are independent of the dimensionality of the diffusion of the Stage-$I_E$ interstitials. Previous attempts to rule out a one-dimensional migration of the Stage-$I_E$ interstitials (and hence the two-interstitial model) on the basis of the alleged agreement of the unsaturable trap model with Stage-II damage curves are thus meaningless. It is demonstrated that the two-interstitial model accounts for minute details of the measured Stage-II damage curves in a natural way. (auth)

**28672** IMPORTANCE OF THE IRRADIATION BEHAVIOR FOR THE SELECTION AND DEVELOPMENT OF HIGH-TEMPERATURE ALLOYS FOR THE CONSTRUCTION OF REACTORS. Boehm, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Arch. Eisenhuettenwes.; 45: No. 12, 821-830(Dec 1974). (In German).

12 figs.; 1 tab.; 63 refs.

A survey is given on the various radiation damage which may be caused to high-temperature alloys under reactor irradiation depending upon operating temperature and neutron flux of the reactor. The relationship with the chemical composition and the structure of the material in the initial state is described. Consequences for the further development of the materials are shown. The considerations covered primarily the austenitic steels. (auth)

**28673** FORMATION AND STRUCTURE OF ANODIC FILMS ON BERYLLIUM. Shehata, M. T.; Kelly, R. (McMaster Univ., Hamilton, Ont.). J. Electrochem. Soc.; 122: No. 10, 1359-1365 (Oct 1975).

The present, as well as previous, work on the anodizing of Be confirms that most electrolytes yield films characterized by one or more of being porous, being subject to extensive dissolution, or being crystalline. This includes electrolytes based on the following: aqueous KOH, a $CrO_3$-$HNO_3$ mixture, aqueous $Na_2CO_3$, $(C_2H_5)_2HPO_4$, a $(C_2H_5)_2SO_4$-$H_2SO_4$ mixture, acetic acid. Significantly different results are obtained with ethylene glycol which is saturated with $Na_2HPO_4$ or $KH_2PO_4$ or both $Na_2HPO_4$ and $Na_2SO_4$. The films are then nonporous, as shown by scanning electron microscopy. They are formed with negligible dissolution, as follows by implanting the Be with 30-keV $^{85}$Kr before anodizing and noting the loss of activity during anodizing. They are nominally amorphous, as inferred by reflection electron diffraction, though crystallize to hexagonal BeO at a temperature lying somewhere below 300°C. (auth)

# Other Materials

*Refer also to abstracts 27552, 27571, 27576, 27617-27619, 27668, 27669, 27672, 27679, 27903, 27976, 28133, 28134, 28639, 28648, 28649, 28732, 30220, 30228, 30235, 30305, and 30425.*

**28674** (CNEA-391) DETERMINATION OF THE MIGRATION OF A PLASTICIZER BY $^{14}$C-LABELED COMPOUNDS. Pisarello de Troparevsky, M. L.; Troparevsky, A.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1975. 11p. (In Spanish). Dep. NTIS (US Sales Only) $4.00.

The migration rate of a plasticizer (dioctyl phthlate $^{14}$C) from a P.V.C. film, with different media in contact with it, was determined by measurements of radioactivity in the extraction liquids. Mineral oil, vegetal oil, aliphatic hydrocarbon and detergent solution were used for this purpose. The resulting figures were compared to those obtained from weight loss determinations and in some cases the percentage of "swelling" of the plastic could be established. (auth)

**28675** (JINR-R-14-7974) HEMATITE PHASE DIAGRAM IN A MAGNETIC FIELD. I. Low-Temperature Modification. Balanda, M.; Nitts, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 19p. (In Russian). INIS.

The behavior of hematite crystals in an external field at temperatures below the Morin point was examined. Analysis of experimental data showed that in the phase diagram there are lines of tricritical and lines of critical points. (tr-auth)

**28676** (JINR-R-14-7986) PHASE DIAGRAM OF HEMATITE IN A MAGNETIC FIELD. II. High-Temperature Modification. Balanda, M.; Nitts, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 16p. (In Russian). INIS.

The behavior of a weakly ferromagnetic modification of hematite in an external magnetic field was analyzed thermodynamically. A complete phase diagram was constructed for the magnetically ordered state of hematite in a field directed to the plane of symmetry. The temperature dependence of anisotropy constants above the Morin point was analyzed. (tr-auth)

**28677** (DP-Report-796) STRESS-STRAIN CHARACTERISTICS OF NONIRRADIATED AND IRRADIATED NUCLEAR GRAPHITES. Dragon Project. Everett, M. R.; Ridealgh, F. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jun 1972. 22p. (CONF-720609-11). Dep. NTIS (US Sales Only) $4.25.

From international carbon conference; Baden-Baden, Federal Republic of Germany (26 Jun 1972).

The tensile stress-strain and set characteristics of irradiated and nonirradiated Gilsocarbon graphite are investigated at room temperature and after constant stress temperature-cycle conditions up to 1100°C. Results from post-irradiation examination of the mechanical properties of annular fuel compacts and graphite irradiated in the Dragon Reactor at temperatures in the range 900 to 1200°C and fast neutron doses of up to $3 \times 10^{21}$ n $cm^{-2}$ Ni Dido are presented. Over this range of irradiation conditions the results indicate a near linear and approximately constant relationship between ultimate strength and Young's Modulus and support a constant strain to failure criterion rather than the usually accepted constant strain energy criterion. (auth)

**28678** (INIS-mf-1722) MULTIPLE DIFFRACTION OF X-RAYS IN IRRADIATED MONOCRYSTALS OF LiF. Imakuma, K. (Sao Paulo Univ. (Brazil). Instituto de Fisica). Dec 1972. 165p. (In Portuguese). INIS.

Application of the x-ray multiple diffraction technique is described in the study of crystalline defects caused by irradiation. First the process of multiple diffraction is discussed, including calculation of intensities, physical parameters that take part in diffraction, and angular positions of the peaks. The experimental procedure is described, including monochromization of the beam and sample irradiations. Results are analyzed and discussed; mosaic distributions and lattice parameters are given. The contribution made here are in developing measurement techniques, establishing criteria about the necessary mechanical precision of the instruments, and obtaining some original results, for example: establishing in experimental form the possibility of having an anisotropic mosaic distribution in the crystals. (INIS)

**28679** (JUL-1202) ABOUT THE MICROPOROSITY OF PYROCARBON DETERMINED BY X-RAY MEASUREMENT. Investigation of Its Influence on the Material Properties and the Irradiation Behavior of Fuel Particles Coatings. Krautwasser, P. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). May 1975. 155p. (In German). Dep. NTIS (US Sales Only) $10.75.

Thesis. Submitted to Technische Hochschule, Aachen.

This paper is concerned with the application of small angle x-ray scattering to the investigation of the microporosity of pyrocarbon coatings. Unambiguous correlation between the deposition parameters and the pore size distribution of the pyrocarbon is shown. The change of the pore spectrum during heat treatment and neutron irradiation and the relationship of the porosity to the microstructure, fracture stress, and the relative oxidation rate of the coatings is discussed. The properties of the pyrocarbons can be interpreted in terms of three microstructural components which can be differentiated by their pore size distribution, inner surface area, and local density fluctuation, each of which is deduced from the scattering curve. The microstructure and, as a consequence, the irradiation behavior can therefore be estimated from the x-ray scattering data. (auth)

**28680** (LBL-3758) DEFECTS IN BORON ION IMPLANTED SILICON. Wu, W. K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1975. Contract W-7405-ENG-48. 122p. Dep. NTIS $9.25.

Thesis.

The crystal defects formed after post-implantation annealing of B-ion-implanted Si irradiated at 100 keV to a moderate dose ($2 \times 10^{14}$/$cm^2$) were studied by transmission electron microscopy. Contrast analysis and annealing kinetics show at least two different kinds of linear rod-like defects along broken bracket 110 broken bracket directions. One kind either shrinks steadily remaining on broken bracket 110 broken bracket at high temperatures (greater than 850°C), or transforms into a perfect dislocation loop which rotates toward broken bracket 112 broken bracket perpendicular to its Burgers vector. The other kind shrinks steadily at moderate temperatures (approximately 800°C). The activation energy for shrinkage of the latter (3.5 ± 0.1 eV) is the same as that for B diffusion in Si, suggesting that this linear defect is a boron precipitate. There also exist a large number of perfect dislocation loops with Burgers vector a/2 broken bracket 110 broken bracket. The depth distribution of all these defects was determined by stereomicroscopy. The B precipitates lying parallel to the foil surfaces are shown to be at a depth of about 3500 ± 600 A. The loops are also at the same depth, but with a broader spread, ±1100 A. Si samples containing B and samples containing no B (P-doped) were irradiated in the 650-kV electron microscope. Irradiation at 620°C resulted in the growth of very long linear defects in the B-doped samples but not in the others, suggesting that at 620°C Si interstitials produced by the electron beam replace substitutional B some of which precipitates in the form of long rods along broken bracket 110 broken bracket. (DLC)

**28681** (UCRL-77116) THREE-DIMENSIONAL STRESS DISTRIBUTION OF A DOUBLE-CANTILEVER BEAM WITH A SIDE NOTCH. Kirkwood, W. F.; Prado, M. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Aug 1975. 23p. (CONF-750836-1). Dep. NTIS $4.25.

From 9th national symposium on fracture mechanics; Pittsburgh, Pennsylvania, USA (25 Aug 1975).

The effect of a side notch used as a crack guide in a double-cantilever-beam specimen is investigated. The resulting stress distribution along the section of symmetry ahead of the notch is obtained from a three-dimensional photoelastic model. The effect of this side notch, through the thickness and down the side of the specimen is determined. After stress freezing, the model was sliced along principal planes. Along the x-x plane of symmetry, the principal stresses were determined by graphical integration of Filon's transformation of the Lame'-Maxwell equations and by subslicing along the x-z plane. Results of the investigation are in good agreement with those of other investigators. The side notch increases the value of the maximum tensile stress at the intersection of the starter notch and the side notch by approximately 22 percent. (auth)

**28682** PREPARATION AND CHARACTERIZATION OF CRYSTALS OF THE SUPERCONDUCTING POLYMER, (SN)/sub x/. Street, G. B.; Arnal, H.; Gill, W. D.; Grant, P. M.; Greene, R. L. (IBM Research Lab., San Jose, CA). Mater. Res. Bull.; 10: No. 9, 877-881(Sep 1975).

A technique is described for growing (SN)/sub x/ crystals which have superior electrical properties to those reported previously. The room temperature electrical conductivity has increased; so has the ratio of the room temperature and 4°K resistivities. There is no conductivity maximum in the region 20–30°K and the superconducting transition temperature is higher. (auth)

**28683** SOME LOW TEMPERATURE TRANSPORT PROPERTIES AND SUPERCONDUCTIVITY OF $NbSe_2$ GROWN BY DIRECT VAPOR TRANSPORT. Lewis, N. E.; Leinhardt, T. E.; Dillard, J. G. (Virginia Polytechnic Inst., Blacksburg). Mater. Res. Bull.; 10: No. 9, 967-975(Sep 1975).

A procedure for the preparation of 2H-$NbSe_2$ single crystals by a direct vapor transport method is reported. Crystals grown by this method and the iodine vapor transport method are studied in a comparative fashion. The effect of iodine and other impurities on some of the low-temperature transport properties including superconductive parameters is discussed. (auth)

**28684** REINFORCEMENT OF THE ALLOY Ni + 2 wt % $HfO_2$ BY MECHANICOTHERMAL TREATMENT. Plechev, V. N.; Shchegoleva, R. P.; Dzneladze, Zh. I. (Central Scientific Research Inst., Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 34-37(May 1975). (In Russian).

Regularities of changes in the yield limit, ultimate strength, and resistivity of precipitation-strengthened nickel under the effect of repeated preliminary strain with intermediate annealings at 1200°C are examined. An increase in durability characteristics of the material is connected with the formation of the dislocation forest structure stable up to 0.8 $T_{melt}$. (auth)

**28685** SURFACE STRUCTURE OF REDUCED PARTICLES OF MOLYBDENUM ANHYDRIDE. Panichkina, V. V.; Strashinskaya,

L. V. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 5-8(Jun 1975). (In Russian).

The surface structure of the particles of molybdenum anhydride, intermediate oxides, and metal powder was examined during the reduction process. When reduced in the presence of palladium, the metal particles under formation are shown to be agglomerates of smaller particles because of a drop in the reduction temperature of the first stage. The data are used to explain the specific surface high values for such powders. (auth)

**28686** SYNTHESIS OF Dy TO Lu AND Y METABORATES. Tananaev, I. V.; Dzhurinskii, B. F.; Chistova, V. I. (Inst. of General and Inorganic Chemistry, Moscow). Inorg. Mater.; 11: No. 1, 69-72(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 86-90(Jan 1975).

By reacting rare earth oxides with a melt of the composition $Na_2O{\cdot}19B_2O_3$, metaborates $Ln(BO_2)_3$ with Ln = Dy, Y, Ho, Er, Tm, Yb, and Lu were synthesized. The thermal stability of the metaborates was investigated. From the structural viewpoint the metaborates are divided into the following groups: $Dy(BO_2)_3$; Ho, Er, Tm, $Y(BO_2)_3$; Yb, $Lu(BO_2)_3$. (auth)

**28687** SYNTHESIS OF LANTHANUM METANIOBATE (III) WITH INCORPORATED EUROPIUM OXIDE. Kasimov, G. G.; Elovskikh, E. M.; Krylov, E. I. (Ural Polytechnic Inst., USSR). Inorg. Mater.; 11: No. 1, 153(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 180(Jan 1975).

The reaction $(1 - x)\ LaO_{1.5} + x\ EuO_{1.5} + 0.6\ NbO_{2.5} + 0.4\ Nb \rightarrow La_{1-x}Eu_x\ NbO_3$ was accomplished at ~ 1000°C. After 3h at 1000–1200°C, the cubic phase of the metaniobate was detected, and the lattice constant decreases with $Eu_2O_3$ content. Eu $NbO_3$ is stable in air at room temperature. (DLC)

**28688** GROWTH AND CHIEF PROPERTIES OF CRYSTALS OF RARE EARTH AND YTTRIUM OXYTUNGSTATES, $Ln_2WO_6$. Yanovskii, V. K.; Voronkova, V. I. (Moscow State Univ.). Inorg. Mater.; 11: No. 1, 73-76(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 91-94(Jan 1975).

Crystals of the oxytungstates of the rare earths and Y, of the composition $LN_2WO_6$, were grown. Morphologies, optical characteristics, and certain other properties of these crystals were investigated. The oxytungstates $Ln_2WO_6$ can be divided into three structural types. Crystals of group II, from $Pr_2WO_6$ to $Dy_2WO_6$ inclusive, have the symmetry m. Crystals of group III, from $Ho_2WO_6$ to $Lu_2WO_6$ and $Y_2WO_6$, belong to the class 2/m. Their properties and morphologies are consistent with a structure of the scheelite type which was proposed for $Nd_2WO_6$. Crystals of $La_2WO_6$ differ from the others. They are hexagonal and have anomalously high density, showing that they apparently have closer-packed structure. (auth)

**28689** CRYSTALLIZATION OF BINARY SODIUM ZIRCONIUM AND SODIUM HAFNIUM MOLYBDATES FROM SOLUTION IN MELTS, AND SOME OF THEIR PROPERTIES. Zolotova, E. S.; Podberezskaya, N. V.; Klevtsov, P. V. (Inst. of Organic Chemistry, Novosibirsk, USSR). Inorg. Mater.; 11: No. 1, 77-79(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 95-98(Jan 1975).

Binary sodium zirconium and sodium hafnium molybdates $Na_2M^{IV}(MoO_4)_3$ were synthesized by solid-phase reactions. Single crystals of these compounds have been obtained by crystallization from solutions in sodium polymolybdate melts. The compounds melt with decomposition at 610 and 620°C respectively; they crystallize in a scheelitelike monoclinic structure (Fedorov group I2/c). (auth)

**28690** CORRELATION BETWEEN CERTAIN OPTICAL AND CRYSTALLOCHEMICAL PROPERTIES OF SOLID SOLUTIONS. Talanov, V. M.; Vorob'ev, Yu. P.; Men, A. N.; Levchenko, V. M. (Inst. of Metallurgy, Ural, USSR). Inorg. Mater.; 11: No. 1, 128-130(Jan 1975).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 11: No. 1, 154-157(Jan 1975).

The correlation of the concentration dependence of some optical and crystallochemical properties by the cluster component method is discussed. In this method, a real solid solution is represented as a set of noninteracting subsystems (clusters), each of which makes an additive contribution to the property. To test this method, the following systems were investigated: $Y_3Fe_5O_{12}-Gd_3Fe_5O_{12}$, $Y_3Ga_5O_{12}-Y_3Al_5O_{12}$, and $MgAl_2O_4-MgCr_2O_4$. Variations of lattice parameter and absorption peak max with composition were linear. (DLC)

**28691** ROLE OF TUNNELING RECOMBINATION IN RADIATION-INDUCED F-CENTER CREATION IN ALKALI HALIDE CRYSTALS AT LIQUID HELIUM TEMPERATURES. Tale, I.; Millers, D.; Kotomin, E. (Latvian State Univ., Riga). J. Phys., C (London); 8: No. 15, 2366-2375(7 Aug 1975).

Computer simulations of the F-center accumulation at liquid helium temperatures (LHT) in alkali halides, taking into account the spatial distribution and the tunneling recombination of the localized F- and H- centers, were undertaken. The model easily explains known experimental data at these temperatures: (i) the saturation and possible subsequent decay of the F-center production rate, (ii) the existence of an abnormally high fraction of the aggregate ($F_2$, $H_2$,...) centers (in contrast to random distribution), (iii) the formation of large loose aggregates, (iv) the existence of F-center concentrations exceeding $10^{19}cm^{-3}$, and (v) the dependence of the production curve on the excitation intensity. A mechanism for loose-aggregate formation is proposed. The applicability of the present model at room temperature is discussed. (auth)

**28692** PRESSURE-DEPENDENT SUSCEPTIBILITY OF SINGLET-GROUND-STATE PARAMAGNETS: Pr AND Tm MONOPNICTIDES AND Pr MONOCHALCOGENIDES. Guertin, R. P. (Tufts Univ., Medford, MA); Crow, J. E.; Longinotti, L. D.; Bucher, E.; Kupferberg, L.; Foner, S. Phys. Rev., B; 12: No. 3, 1005-1014(1 Aug 1975).

Measurements of the pressure dependence (up to approximately 6 kbar) of the magnetic susceptibility chi at $4.2^0$K are presented for three Pr monopnictides (PrAs, PrSb, and PrBi), two Tm monopnictides (TmAs and TmSb), and three monochalcogenides (PrS, PrSe, and PrTe). Results for (1/chi) (d chi/dP) in units of $10^{-3}kbar^{-1}$ are: PrAs +10; PrSb, +7; PrBi, +9; TmAs, +6; TmSb, +3; PrSe, -2; and PrTe, -1; for PrS, (1/chi)(d chi/dP) is nonmonotonic, but negative. Independent inelastic-neutron-scattering data, which show that for all the materials studied the crystalline electric field (CEF) of the surrounding ions produces a nonmagnetic (singlet) ground state with a magnetic (triplet) first excited state, are employed for analysis of the present experiments. None of the compounds studied orders magnetically; the susceptibility is Van Vleck like, and is nearly temperature independent at $4.2^0$K. For both sets of monopnictides, the susceptibility increases under pressure, whereas the point-charge model, which has been used previously to explain the CEF splittings, always predicts a decrease. For the monochalcogenides, the susceptibility decreases slightly, consistent with the predictions of the point-charge model. The results are discussed in terms of the predictions of the point-charge model, the pressure dependence of the enhancement, and other possible mechanisms. (auth)

**28693** CUBIC RARE-EARTH COMPOUNDS: VARIANTS OF THE THREE-STATE POTTS MODEL. Kim, D.; Levy, P. M.; Uffer, L. F. (New York Univ.). Phys. Rev., B; 12: No. 3, 989-1004(1 Aug 1975).

In appropriate cubic fields, rare-earth ions have sixfold degenerate ground states. When the angular momentum of the rare earth is large, the six levels are characterized by states that are directed along the cube edges. Within these states the angular momentum operators J/sub x/, J/sub y/, and J/sub z/ have particularly simple matrix representations. The projection of an isotropic pair coupling between the rare earths onto these sixfold degenerate states leads to an interaction Hamiltonian H equals -I SIGMA/sub (ij)/ sigma/sub i/sigma/sub j/delta/sub l/sub i/sub l/sub j//, where sigma takes on the values +-1 and l the values x, y, and z. This interaction is a variant of the three-state Potts model. Magnetic and quadrupolar anisotropy field terms are added to the Hamiltonian and the symmetry properties of the phase diagram associated with this model are determined. For nonzero quadrupolar anisotropy fields, the model is shown to have the thermodynamic behavior of an Ising model. However, for zero fields a new symmetry appears and in the mean-field approximation the model has tricritical-like exponents. This simple model is able to account for the large specific-heat critical exponent alpha' equals 1/2 which has been observed for holmium antimonide in zero external fields. To the extent that the mean-field approximation is an accurate guide, we predict there are many cubic rare-earth compounds which exhibit tricritical-like behavior in zero field. In addition, for pure quadrupole coupling between rare earths in the sixfold degenerate states, the interaction Hamiltonian is exactly the three-state Potts model. In the mean-field approximation this system has a first-order phase transition. However, a small quadrupolar anisotropy field is sufficient to drive the system to a wing critical point. The specific heat has a critical exponent of alpha equals 2/3 or 1 depending on the path taken to approach this critical point. (auth)

**28694** HYDROGENIC ATOMS IN "SUPERSTRONG" MAGNETIC FIELDS. Glasser, M. L. (Waterloo Univ., Ontario (Canada). Dept. of Applied Mathematics); Kaplan, J. I. (Indiana-Purdue Univ., Indianapolis (USA)). Phys. Lett., A; 53: No. 5, 373-374(14 Jul 1975).

An estimate is made of the magnetic field above which many recent non-relativistic treatments of hydrogenic atoms in strong magnetic fields become invalid. It is argued that this value may be as low as $10^{10}Z$ Gauss. (auth)

**28695** PRUEFUNG VON ISOLIERSTOFFEN. Bestimmung der Bestaendigkeit Gegenueber Energiereichen Strahlen. (Testing of Electrical Insulating Materials. Determination of the Resistance to Ionizing Radiation). Berlin; Beuth (Jan 1975). 3p.

Permanent changes in the electrical and mechanical properties of organic and inorganic insulating materials, mainly plastic materials, induced by irradiation under different conditions (absorbed dose rates) were determined. (GE)

**28696** HEAT-STIMULATED CONDUCTIVITY IN IRRADIATED LiF CRYSTALS. Igitkhanishvili, D. D.; Kvavadze, K. A. pp 29-31 of Ekektronnye i ionnye Protsessy v Tverdykh Telakh. VII. Tbilisi, USSR; Izdatel'stvo Metsniereba (1974). (In Russian).

In gamma ($^{60}$Co) irradiated LiF crystals, an intense peak of heat-stimulated conductivity was demonstrated in the temperature interval 140-180°K, with a maximum at about 160°K. There is also a thermoluminescence peak at this temperature. In the temperature range 290-390°K there was a complex heat-stimulated conductivity peak, actually two peaks with maximums at 340 and 365°K. The intensity of absorption of the F band in this temperature range was lower. This indicates that annealing occurs with participation of electrons released in destruction of F centers. The intensity of all thermostimulated conductivity peaks was greater with a gamma dose of $1.35 \times 10^7$ R than with a dose of $9 \times 10^6$ R. (TTT)

**28697** CRYSTAL STRUCTURE OF $U_2Ni_2Si_7$ COMPOUND. Akselrud, L. G.; Yarmolyuk, Ya. P.; Hladyshevsky, E. I. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 7, 643-645(Jul 1975). (In Ukrainian).

The crystal structure of the new compound $U_2Ni_2Si_7$ was determined by means of the x-ray powder method. The lattice parameters for the base-centered orthorhombic cell are: a = c = 3.964, b = 20.85 Å, the space group is Cmmm, N = 22, the positions of atoms: 4U in 4(i) 0y0, y = 0.170; 2Ni in 2(a) 000; 4($Ni_{0.5}Si_{0.5}$) in 4(j) 0y½, y = 0.386, 4$Si^{(1)}$ in 4(i) 0y0, y = 0.437; 4$Si^{(2)}$ in 4(j) 0y½, y = 0.063; 4$Si^{(3)}$ in 4(j) 0y½, y = 0.722. The structure is of a new type; it belongs to the homologous series based on the types $AlB_2$, $BaAl_4$, and $CaF_2$. (auth)

**28698** CRITERIA FOR BOMBARDMENT-INDUCED STRUCTURAL CHANGES IN NON-METALLIC SOLIDS. Naguib, H. M. (McMaster Univ., Hamilton, Ont.); Kelly, R. Radiat. Eff.; 25: No. 1, 1-12(1975).

From 2nd Cairo solid state conference; Cairo, Egypt (1973).

Structural transformations in nonmetallic solids induced by energetic heavy ions at intermediate ($\sim 10^{13}$ to $10^{16}$ ions/cm$^2$) and high ($\gtrsim 10^{17}$ ions/cm$^2$) doses normally take the form of amorphization, crystallization, or stoichiometry changes. Using the results of 72 substances, both a temperature-ratio and a bond-type criterion are shown to be successful in predicting the occurrence of amorphization or crystallization. The former, based on a physical model involving thermal spikes, states that amorphization should occur whenever the ratio (crystallization temperature)/(melting point) exceeds 0.30. The latter, of more or less empirical origin, states that amorphization should occur whenever the ionicity is $\leq 0.47$. Stoichiometry changes are basically different from amorphization and crystallization and this is reflected in the criterion. It is shown that whether or not a substance (such as AgBr or $TiO_2$) loses a component (such as Br or O) during bombardment correlates with the heat of atomization showing a minimum for a particular degree of loss. One of the intended applications of the present work lies in predicting which minerals ought to contain fission-fragment tracks and therefore be useful for geological dating. It is argued that minerals consisting wholly or in part of the following may be interesting: $Nb_2O_5$, $Ta_2O_5$, $V_2O_5$, and $WO_3$. (auth)

**28699** TEMPERATURE DEPENDENCE OF THE ACCUMULATION OF RADIATION DEFECTS IN ALLOYED $CaF_2$ CRYSTALS. Lisitsyn, V. M.; Shtan'ko, V. F. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 116-118(1975). (In Russian).

In order to study the temperature dependence of the accumulation of photochrome centers, $CaF_2$ crystals with admixtures of Y, Ce, Gd, or Tb (0.003 to 0.3 wt.%) were irradiated with 1.2-MeV electrons in the temperature interval from 78 to 300°K. The optical absorption spectra were measured at 78°K and the thermoluminescence was measured at heating rates of 6°/min. In crystals irradiated at 300°K, bands caused by photochrome centers are observed. As the irradiation temperature is decreased these bands decrease in intensity and disappear. Heating the crystals irradiated at low temperature causes the appearance of the photochrome centers, but heating the crystals above 300°K leads to the annealing of these centers. Heating of the crystals is accompanied by luminescence. The kinetics of the formation of low-temperature defects and their transformation into photochrome centers is discussed. (JSR)

**28700** RADIATION-INDUCED CONVERSION OF F AND M CENTERS IN $CaF_2$ CRYSTALS. Korepanov, V. I.; Lisitsyn, V. M.; Baranov, A. I.; Stepanov, V. G.; Zhaparova, S. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 118-120(1975). (In Russian).

The absorption spectra of additively colored $CaF_2$ crystals have two bands caused by F and M centers. Irradiation of the crystals with 1.2-MeV electrons causes the disappearance of F centers and the appearance of F-aggregate color centers. There is also a decrease of the concentration of M centers. The conversion of the simplest F centers into complex aggregates was confirmed by the absorption spectrum of proton-irradiated $CaF_2$–Na crystals (0.02 M% Na). At low irradiation doses the Na M luminescent centers are preferentially formed. (JSR)

**28701** CALCULATIONS OF F CENTRE ENDOR RESULTS. Lowther, J. E. (University of the Witwatersrand, Johannesburg (South Africa). Dept. of Physics). Physica; 79: No. 2, 148-158 (1975).

The calculation of isotropic ENDOR hyperfine parameters is critically examined. Conclusions are drawn concerning the effects of the non-orthogonality of the ionic orbitals and inclusion of extra anisotropic terms in the pseudo-wavefunctions representing the F centre in the alkali halides. (auth)

# NUCLEAR MATERIALS AND WASTE MANAGEMENT

**28702** PROBLEMS AND PROSPECTS IN THE MANAGEMENT OF SOLID RADIOACTIVE WASTE. Wolfe, R. A. (Energy Research and Development Administration, Washington, DC). J. Environ. Sci.; 18: No. 4, 9-15(1975).

From conference on energy and the environment; Anaheim, California (Apr 1975).

Large volumes of contaminated solid waste materials arise in the nuclear fuel cycle that will have to be collected, processed and disposed. Primary sources of these wastes and their characteristics are described along with estimates of their quantity. Processes for the treatment of these wastes to reduce their volume, provide for decontamination or recovery, and prepare residues for long-term storage are being developed to improve the management of these materials. Candidate processes of treatment and suggested methods of reducing the quantity of such materials are described along with the current methods of storage and projected methods of disposal. (auth)

**28703** CONTROL OF GASEOUS EFFLUENTS IN THE NUCLEAR INDUSTRY. Stuart, R. W. J. Environ. Sci.; 18: No. 4, 26-34(1975).

From conference on energy and the environment; Anaheim, California (Apr 1975).

The nature and quantity of gaseous releases and the means of controlling and/or treating such releases, and trends that are becoming evident in effluent control are discussed. It is pointed out that effluent control has been going through an evolutionary period with a resultant clarification and qualification of requirements and a developing understanding and rationality with respect to the techniques being used for control. It is concluded that although some areas require further work and understanding, the level of public exposure resulting from the nuclear power industry is extremely low and not hazardous. (auth)

## Accountability and Safeguards

*Refer also to abstracts 27458, 27535, 27695, and 27696.*

**28704** (CONF-740308-) PRACTICAL APPLICATIONS OF R AND D IN THE FIELD OF SAFEGUARDS. Proceedings of European Safeguards Research and Development Symposium, Rome, Italy, March 7–8, 1974. (European Safeguards Research and Development Association (ESARDA), Rome (Italy)). 1974. 404p.

During the first session, representatives of the European Commission described the features and evolution of safeguards systems and presented data on the nuclear material to be safeguarded in the fuel cycle within the European Community. The next two sessions discussed accountancy, surveillance, and containment techniques, and the relevant destructive and nondestructive measurements. The final session was a discussion devoted to questions mainly by plant operators and to other topics. Separate abstracts were prepared for the nine papers. (DLC)

*For abstracts of individual papers see: 27458, 27695, 27696, and 28705–28710.*

**28705** (CONF-740308-, pp 25-38) BASIC FEATURES OF SAFEGUARDS SYSTEMS, RELATED TO R AND D ACTIVITIES. Schleicher, H. W. (EURATOM, Luxembourg). 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

It is pointed out that nuclear safeguards must also be international safeguards. Objectives and scope of safeguards are reviewed; the peculiar mixture of political and technical aspects in international safeguards is emphasized. Conditions for an efficient safeguards system are given. The present safeguards situation in the European Community is discussed. The two relevant documents are the Euratom Treaty and the Verification Agreement. Operations of the inspectors are described. Contributions of R and D to the complex are considered: actual and future, scientific, political, and economic. (DLC)

**28706** (CONF-740308-, pp 97-144) PRACTICAL ASPECTS OF NUCLEAR MATERIAL ACCOUNTANCY AND THEIR APPLICATIONS TO SAFEGUARDS. Harry, R. J. S. (Reactor Centrum Nederland, Petten); Anderson, A. R.; Rota, A.; Kraemer, R.; Kschwendt, H. 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

This paper discusses the components of nuclear material accountancy systems. The needs of an effective management/operational system are described and the additional specific requirements for safeguards purposes are identified. Procedures for inventory taking, treatment of material unaccounted for (MUF), and record/report forms are dealt with in detail in appendices. (DLC)

**28707** (CONF-740308-, pp 145-181) SURVEILLANCE AND CONTAINMENT TECHNIQUES. Crutzen, S.; Jehenson, P. (EURATOM, Ispra, Italy). 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

Surveillance means the observation by an inspector that the operations carried out on nuclear materials are legitimate; containment means that of the material within specified boundaries against diversion attempts. This paper describes various surveillance and identification techniques which have been developed for safeguards purposes, and summarizes work on the development of seals at Ispra. (DLC)

**28708** (CONF-740308-, pp 227-261) ROLE OF MEASUREMENTS OF NUCLEAR MATERIALS IN SAFEGUARDS. Beets, C. (CEN/SCK, Mol, Belg.). 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

This paper is an introduction to the role of technical measurements in safeguards. Particular problems associated with measurements in the fuel cycle are discussed. Knowledge of the properties used for measurements, and of the measuring methods, is summarized in annexes. (DLC)

**28709** (CONF-740308-, pp 263-306) APPLICATION OF NEUTRON TECHNIQUES FOR NONDESTRUCTIVE MEASUREMENTS IN SAFEGUARDS. Terrey, D. R. (Atomic Energy Research Establishment, Harwell, Eng.). 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

This paper gives general information on neutron detection, discusses major developments in this field, and shows how those methods can be applied in different areas of the fuel cycle. Methods include total neutron counting, spontaneous fission, delayed neutrons, prompt fission, fast coincidence, delayed fission gamma, photofission, reactivity, neutron transmission, etc. Detectors, fuel types, calibration, heterogeneity, etc. are discussed. (16 fig, 44 references) (DLC)

**28710** (CONF-740308-, pp 307-361) APPLICATIONS OF GAMMA RAY TECHNIQUES IN SAFEGUARDS. Bresesti, A. M.; Bresesti, M. (EURATOM, Ispra, Italy). 1974.

From European safeguards research and development symposium; Rome, Italy (7 Mar 1974).

In practical applications of R and D in the field of safeguards.

A review is presented of techniques for measuring gamma rays emitted by fissile materials and fission products during their decay. Gamma-ray absorption measurements were also treated. Detectors and instrumentation are described. General aspects of the application of these techniques in safeguards are presented. The principle of enrichment measurements is discussed. Applications for the measurement of different fresh fuels (highly enriched U cycle, low enrichment U cycle, U–Pu cycle) and of irradiated fuels are presented. The most important applications are tabulated. (24 fig, 5 tables, 33 references) (DLC)

**28711** (CONF-751017-1) COMPUTERIZED REAL-TIME MATERIALS ACCOUNTABILITY SYSTEM FOR SAFEGUARDS MATERIAL CONTROL. Spencer, W. F.; Affel, R. G.; Austin, H. C.; Nichols, J. P.; Stoutt, B. H.; Wachter, J. W. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Computer Sciences Div.). 1975. 4p. Dep. NTIS $4.00.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

A real-time, computer-based system is described which provides safeguards material control at the Oak Ridge National Laboratory. Originally installed in 1972 to provide computerized real-time fissile materials accountability for criticality control purposes, the system has been expanded to provide accountability of all source and nuclear materials (SNM) and to utilize the on-line inventory files in support of the Laboratory physical protection and surveillance procedures. (auth)

**28712** (LA-UR-75-1469) TAMPER INDICATING RADIATION SURVEILLANCE INSTRUMENTATION. Chambers, W. H.; Ney,

J. F. (Los Alamos Scientific Lab., N. Mex. (USA); Sandia Labs., Albuquerque, N. Mex. (USA)). 1975. Contract W-7405-eng-36. 11p. (CONF-751017-3). Dep. NTIS $4.00.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

Prototype personnel and shipping dock portal monitors suitable for unattended use were fabricated and tested. The requirement for continuous operation with only periodic inspection along with a desire for minimum costs and minimum interference with normal plant operation imposed unique design constraints. The design, operation, and performance of the detection and data recording instrumentation are described, as well as the tamper indicating techniques required to protect the collected data. The essential elements of either of the two instruments include a gamma detector array, signal conditioning electronics, digital alarm logic circuitry, power supplies, a microwave occupancy monitor, surveillance camera, irreversible electromechanical counters, and the appropriate tamper indicating envelope protecting these elements. Attempts to penetrate the tamper indicating envelope require material removal, and undetectable repair is very difficult, if not impossible. The techniques for joining major subassemblies and providing unique seals are also described. The personnel doorway uses a double pole array of NaI(Tl) detectors, and outputs are taken from a single channel pulse height analyzer with a window set at 60 to 250 keV and the lower level discriminator at greater than 60 keV. A sliding interval counter is used to make comparisons to an accumulated background at the 4 sigma level. Logic design, sensitivity for special nuclear materials, false alarm data, and test procedures are described in detail. The shipping dock monitor had different design constraints and therefore uses a single, long, cylindrical plastic scintillator. Some differences in signal conditioning and processing are also described. (auth)

**28713** (LA-UR-75-1524) CONTINUOUS INVENTORY IN SNM STORAGE FACILITIES. Chambers, W. H. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 9p. (CONF-751017-6). Dep. NTIS $4.00.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

Instrumentation and data processing techniques that provide inexpensive verification of material in storage were investigated. Transfers of special nuclear materials (SNM) into the storage area are accompanied by an automated verification of the container identity, weight, and the radiation signature of the contents. This information is computer-processed and stored for comparison at subsequent transfers and also provides the data base for record purposes. Physical movement of containers across the boundary of the storage area is presently accomplished by operating personnel in order to minimize expensive modifications to existing storage facilities. Personnel entering and leaving the storage area are uniquely identified and also pass through portal monitors capable of detecting small quantities of SNM. Once material is placed on the storage shelves, simple, low-cost container tagging and radiation sensors are activated. A portion of the prescribed gamma signature, obtained by duplicate shelf monitors during the transfer verification, is thus continuously checked against the stored identification data. Radiation detector design is severely constrained by the need to discriminate individual signatures in a high background area and the need for low unit costs. In operation any unauthorized change in signal is analyzed along with auxiliary data from surveillance sensors to activate the appropriate alarms. (auth)

**28714** (LA-UR-75-1607) RECENT DEVELOPMENTS IN THE DISSOLUTION AND AUTOMATED ANALYSIS OF PLUTONIUM AND URANIUM FOR SAFEGUARDS MEASUREMENTS. Jackson, D. D.; Marsh, S. F.; Rein, J. E.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 21p. (CONF-751017-5). Dep. NTIS $4.25.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

The status of a program to develop assay methods for plutonium and uranium for safeguards purposes is presented. The current effort is directed more toward analyses of scrap-type material with an end goal of precise automated methods that also will be applicable to product materials. A guiding philosophy for the analysis of scrap-type materials, characterized by heterogeneity and difficult dissolution, is relatively fast dissolution treatment to effect 90 percent or more solubilization of the uranium and plutonium, analysis of the soluble fraction by precise automated methods, and gamma-counting assay of any residue fraction using simple techniques. A Teflon-container metal-shell apparatus provides acid dissolutions of typical fuel cycle materials at temperatures to 275°C and pressures to 340 atm. Gas–solid reactions at elevated temperatures separate uranium from refractory materials by the formation of volatile uranium compounds. The condensed compounds then are dissolved in acid for subsequent analysis. An automated spectrophotometer is used for the determination of uranium and plutonium. The measurement range is 1 to 14 mg of either element with a relative standard deviation of 0.5 percent over most of the range. The throughput rate is 5 min per sample. A second-generation automated instrument is being developed for the determination of plutonium. A precise and specific electroanalytical method is used as its operational basis. (auth)

**28715** (LA-UR-75-1712) IN-PLANT NONDESTRUCTIVE ASSAY OF HTGR FUEL MATERIALS. Atwell, T. L.; Martin, E. R.; Menlove, H. O. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 28p. (CONF-751017-8). Dep. NTIS $4.50.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

The performance characteristics of three different nondestructive assay systems for the measurement of HTGR fuel are described. These include the segmented gamma scanner which uses the passive gamma emission from the $^{235}U$ together with a segment-by-segment axial scan and transmission with an external source to correct for gamma absorption. The Random Driver is an active, fast-neutron interrogation system which employs $^{241}AmLi$(alpha,n) neutron sources to induce fissions in the sample fissile material. This system is applicable to bulk samples of HTGR fuel particles and large groups of fuel rods. The third system considered is the $^{252}Cf$ Fuel Rod Assay System, which uses thermal neutron interrogation and prompt-fission neutron counting to measure the total fissile content in a fuel rod or stack. In addition, the pellet-to-pellet or rod-to-rod uniformity is measured by counting the delayed gamma rays in a NaI(Tl) through-hole detector. (auth)

**28716** (LA-UR-75-1817) NONDESTRUCTIVE ASSAY TECHNOLOGY AND IN-PLANT DYNAMIC MATERIALS CONTROL: "DYMAC". Keppin, G. R.; Maraman, W. J. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 24p. (CONF-751017-9). Dep. NTIS $4.25.

From symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

An advanced system of in-plant materials control known as DYMAC Dynamic Materials Control is being developed. This major safeguards R and D effort merges state-of-the-art nondestructive assay instrumentation and computer technology, with the clear objective of demonstrating a workable, cost-effective system of stringent, real time control of nuclear materials in a modern plutonium processing facility. Emphasis is placed on developing practical solutions to generic problems of materials measurement and control, so that resulting safeguards techniques and instrumentation will have widespread applicability throughout the nuclear community. (auth)

**28717** (SZS–165, pp 11-20) PRINCIPLES OF PHYSICAL PROTECTION AND NUCLEAR SAFETY IN STORING NUCLEAR MATERIALS. Gegusch, M. Aug 1974. (In German).

In report of the National Centre for Radiation Protection of the GDR. (Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)).

Unauthorized access to nuclear material may be prevented by administrative and technical measures. Such measures for assuring inaccessible storage are outlined depending on type and enrichment of nuclear materials. As suitable geometry, composition and moderation can cause a selfsustaining nuclear chain reaction, emphasis has to be put on the aspect of nuclear safe storage. The factors influencing the criticality of a nuclear materials arrangement are described. (INIS)

**28718** ALARM SYSTEM FOR DETECTION OF INTRUDERS IN A RESTRICTED AREA. Galvin, A. A.; Shapiro, L. D. (to Aerospace Research, Inc.). German(FRG) Patent 2,429,518/A/. 23 Jan 1975. 17p. (In German).

An alarm system for simultaneous or alternate use in an ultrasonic and/or an electromagnetic control area is described. Electromagnetic and ultrasonic waves of about the same wavelength in air are used. Coupling of both signals reflected from the control area produces a threshold value. Transgression of this threshold value indicates the presence of a moving object in the control area. (GE)

## Disposal and Storage

*Refer also to abstracts 27682, 27694, and 27974.*

**28719** (ARH-1278) PLUTONIUM–AMERICIUM SOIL PENETRATION AT 234-5 BUILDING CRIB SITES. Crawley, D. T.

(Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 10 Jun 1969. Contract AT(45-1)-2130. 7p. Dep. NTIS. $4.00.

Plutonium–americium carried in a slightly acid, high salt waste had penetrated to a depth of 18 feet in the Z-1A tile field, the limit of sampling. Plutonium–americium contained in neutralized low salt waste routed to the Z-12 crib had penetrated the soil to a minor extent, based on sampling to 16 feet. At each disposal site, some concentration of the plutonium–americium was noted at the top layer of soil. (auth)

**28720** (ARH-2806-1Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING FIRST QUARTER 1973. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 5 Jul 1973. Contract AT(45-1)2130. 129p. Dep. NTIS $9.50.

An overall summary is presented giving the radioactive liquid wastes discharged to ground during the first quarter of 1973 and since startup within the chemical Processing Division control zone. A summary of radioactive wastes discharged to individual ponds, cribs, and specific retention sites is given. (LK)

**28721** (ARH-2806-2Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING FIRST HALF 1973. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 19 Oct 1973. Contract AT(45-1)2130. 129p. Dep. NTIS $9.50.

An overall summary is presented giving the radioactive liquid wastes discharged to ground during the first half of 1973 and since startup (for both total and decayed depositions) within the Chemical Processing Division control zone. A list of decayed activities at the various disposal sites is given. (LK)

**28722** (ARH-2806-3Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING THE FIRST THREE QUARTERS OF 1973. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 15 Jan 1974. Contract AT(45-1)-2130. 89p. Dep. NTIS $7.50.

Radioactive liquid wastes discharged to ground during the first three quarters of 1973 and since startup within the Manufacturing and Waste Management Division control zone are summarized in tabular form. The wastes discharged during 1973 to each active disposal site are detailed on a month-to-month basis. (LK)

**28723** (ARH-2806-4Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING 1973. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 15 Apr 1974. Contract AT(45-1)-2130. 93p. Dep. NTIS $7.75.

An estimate of the radioactivity discharged to individual ponds, cribs, and specific retention sites within the Manufacturing and Waste Management Division during 1973 and from startup through December 31, 1973, and an estimate of the decayed activities from startup through December 31, 1973, are tabulated. (LK)

**28724** (ARH-3093-1Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING FIRST QUARTER 1974. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 22 Jul 1974. Contract AT(45-1)-2130. 84p. Dep. NTIS $7.25.

Tables summarizing the radioactive liquid wastes discharged to ground during the first quarter of 1974 and since startup within the Operations Division Control zone are presented. Estimates of radioactivity discharged to individual ponds, cribs, and specific retention sites are also tabulated. (LK)

**28725** (ARH-3093-2Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING FIRST HALF 1974. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 31 Oct 1974. Contract AT(45-1)-2130. 84p. Dep. NTIS $7.25.

A summary of the radioactive liquid wastes that have been discharged to ground in the 200 areas during the first half of 1974 is presented in tabular form. Cumulative data since plant startup are also given. (LK)

**28726** (ARH-3093-3Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING THE FIRST THREE QUARTERS OF 1974. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 31 Dec 1974. Contract AT(45-1)-2130. 83p. Dep. NTIS $7.25.

An overall summary of radioactive liquid wastes discharged to ground during the first three quarters of 1974 and since startup within the Production and Waste Management control zone is presented in tabular form. Estimates of the radioactivity discharged to individual ponds, cribs, and specific retention sites are given. (LK)

**28727** (ARH-3093-4Q) RADIOACTIVE LIQUID WASTES DISCHARGED TO GROUND IN THE 200 AREAS DURING 1974. Anderson, J. D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 28 Mar 1975. Contract AT(45-1)-2130. 84p. Dep. NTIS $7.25.

Radioactive liquid wastes discharged to ground during 1974 and since startup within the Production and Waste Management control zone are summarized in tabular form. Estimates of the radioactivity discharged to individual ponds, cribs, and retention sites are also summarized. (LK)

**28728** (BNL-20421) TRITIUM STORAGE DEVELOPMENT. Progress Report No. 4, April–June 1975. Columbo, P. (Brookhaven National Lab., Upton, N. Y. (USA)). Jul 1975. 33p. Dep. NTIS $4.75.

Preliminary PITC and PC formulations were evaluated with respect to their specific tritiated waste loadings and materials cost. Experimental data suggest the use of lumnite PITC composites, although portland cement formulations are desirable if their density can be increased. Increasing the water/cement ratio was found to increase the leach rate of lumnite PITC. Container pressurization due to evaporative water loss in concrete as a result of temperature exposure is considered. However, the time required for the temperature response of a concrete monolith in a convective environment was found to be substantial. The conceptual process for the fixation of tritiated aqueous waste in PITC is discussed. Leach test results for zirconium hydride in various aqueous environments are presented. These results suggest that a stable hydride, such as is formed by zirconium, may be attractive as a tritium storage medium. (auth)

**28729** (CONF-750401-2) CORROSION EVALUATION OF STAINLESS STEELS EXPOSED IN ICPP HIGH LEVEL RADIOACTIVE WASTE TANKS. Hoffman, T. L. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs–Operations Office). Jan 1975. Contract AT(10-1)-1375. 26p. Dep. NTIS $4.50.

From NACE International Corrosion/75 conference; Toronto, Canada (14 Apr 1975).

Several 300 series stainless steels (welded 304L, 316, 316 ELC, and 348 and unwelded 304L) were corrosion tested in raffinate storage tanks made of the same materials at the Idaho Chemical Processing Plant. After exposure to the raffinate solutions for periods of up to nineteen years, maximum penetration rates of 0.1 mil per year were noted on Type 304L and 348 stainless steels. (auth)

**28730** (INIS-mf-1373) MANAGEMENT OF RADIOACTIVE BY-PRODUCTS FROM A NUCLEAR POWER PLANT. Campbell, W. M. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects). 24 Aug 1973. 23p. (CONF-7310112-1). INIS.

From electrical association meeting; St. John's, Newfoundland, Canada (17 Oct 1973).

In the operation of a nuclear power plant the radioactive wastes or by-products fall into two categories: (a) Wastes produced during normal operation, some of which escape to the environment and some of which are stored at a waste management site. The amount that escapes from a mature CANDU station is about 1% of the maximum recommended by the International Commission for Radiological Protection. (b) Spent fuel which contains over 99% of the radioactivity produced in a reactor. At present, Canada is not planning to reprocess the spent fuel so it will be stored in a facility from which it can be retrieved. Several possible methods for long-term retrievable storage are being evaluated and the preliminary studies will be completed early in 1974. (auth)

**28731** (LA-UR-75-1109) TRITIUM CONTAINMENT AFTER BURIAL OF CONTAMINATED SOLID WASTE. Wheeler, M. L.; Warren, J. L. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 21p. (CONF-751101-12). Dep. NTIS $4.25.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The Los Alamos Scientific Laboratory has used on-site shallow earth burial as the means of disposal of solid radioactive wastes generated in various research and development programs since the mid-1940's. Migration of tritium from its burial ground location was detected at the presently active disposal site in 1970. Research at that time identified asphalt as a material capable of slowing or limiting migration from waste. Since then attempts have been made to contain with asphalt most of the tritium in waste disposals. The actual effectiveness of the asphalting techniques used to contain tritium in solid wastes disposed of by burial are discussed, and mechanisms by which tritium has migrated from burial sites are identified. (LK)

**28732** (ORNL-TM-4827) GAMMA-RADIATION EFFECTS IN GEOLOGIC FORMATIONS OF INTEREST IN WASTE DISPOSAL:

A REVIEW AND ANALYSIS OF AVAILABLE INFORMATION AND SUGGESTIONS FOR ADDITIONAL EXPERIMENTATION. Jenks, G. H. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 26p. Dep. NTIS $4.00.

Literature concerning radiation effects on silicate rock and limestone minerals was reviewed to provide a summary of available information on the effects of gamma radiation on these materials in a waste repository, and to make an evaluation of the need for additional experimental data. The work was composed primarily of a review of some general aspects of radiation damage and energy storage in solids, and of pertinent information on physical and chemical properties of rock-forming minerals, excluding halite. As a result of these investigations, it was concluded that there are no apparent reasons to expect any significant amounts of stored radiation energy in any of the important rock-forming minerals at the maximum gamma doses (approximately $2 \times 10^{10}$ rads) and fast neutron fluences (less than $10^{17}$ cm$^2$, greater than 3.4 keV) that will prevail in rock immediately adjacent to buried wastes. Neither would any significant chemical effects be found in any of the minerals due to irradiation; however, the possibility that significant effects would occur in some of the minerals could not be completely ruled out. (auth)

**28733** PROPOSAL TO IMPROVE RADIOACTIVE DISPOSAL OF REFUSE AFTER METABOLIC RADIO-IODINE THERAPY. Bekier, A. (Kantonsspital Sankt Gallen (Switzerland). Nuklearmedizinische Abt.). Strahlentherapie; 149: No. 5, 499-503(May 1975). (In German).

After metabolic radioiodine treatments of carcinomas of the thyroid, increased activities of $^{131}I$ are secreted from the patient's body by the renal route. The highly radioactive urine represents a serious danger of contamination for the nursing staff and third persons. The ideal conditions for the isolation of treated patients in a department disposing of a sewage disposal system of its own are not fulfilled in many hospitals. Collection of radioactive urine of the patients for the purpose of annihilating radioactivity over several half-lives of $^{131}I$ is extremely intricate. For this reason, a filter system has been developed by means of which one is able to free the radioactive urine of the first five female patients treated from more than 99% of radioactivity. The contaminated locked filter patterns can be stored as "sealed radiation sources" essentially more securely and space saving. The advantages of this system and their practical possibilities of use are discussed. (auth)

## Handling Equipment and Procedures

**28734** (LA-UR-75-1047) TRITIUM HANDLING FACILITIES AT THE LOS ALAMOS SCIENTIFIC LABORATORY. Anderson, J. L.; Damiano, F. A.; Nasise, J. E. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 35p. (CONF-751101-13). Dep. NTIS $4.75.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A new tritium facility, recently activated at the Los Alamos Scientific Laboratory, is described. The facility contains a large drybox, associated gas processing system, a facility for handling tritium gas at pressures to approximately 100 MPa, and an effluent treatment system which removes tritium from all effluents prior to their release to the atmosphere. The system and its various components are discussed in detail with special emphasis given to those aspects which significantly reduce personnel exposures and atmospheric releases. (auth)

**28735** (LA-UR-75-1066) GAS-HANDLING SYSTEM FOR STUDIES OF TRITIUM-CONTAINING MATERIALS. Carstens, D. H. W. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 31p. (CONF-751101-10). Dep. NTIS $4.25.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A gas handling system for preparation and study of tritium containing compounds and materials is described. The system at any one time can handle amounts of DT gas up to about 3 moles and has provisions for purification, storage, and measurement of the gas. Experimental conditions covering the ranges 20 to 800°C and 0.1 Pa to 137 MPa ($10^{-2}$ torr to 20,000 psi) can be maintained. (auth)

**28736** (UCRL-76560) LLL's QUALITY ASSURANCE PROGRAM AND THE DESIGN OF SPECIFIC SYSTEMS: TRITIUM HANDLING FACILITY. Dow, J. P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Feb 1975. 11p. Dep. NTIS $4.00.

Lawrence Livermore Laboratory operates a Tritium Handling Facility for several programs. Besides the tritium work for the weapons program, basic research is conducted on all phases of tritium. Additional work is being conducted for the laser fusion program and the controlled thermonuclear program. The Quality Assurance Program for the tritium facility and how it is being implemented on specific tritium handling systems are described. The program is intended to prevent or mitigate the consequences of accidents by rigidly controlling the design, fabrication, procurement, construction and operation of safety-related critical structures, systems, and components of such facilities. (CH)

**28737** HANDSCHUHKAESTEN. Zusatzausruestung. Entwurf. (Glove Boxes. Accessories. Draft). Berlin; Beuth (Nov 1974). 3p.

A survey on the auxiliary equipment for different fields of application of glove boxes is presented. Airlocks, closures, electric and media installation, operation, ventilation, annexes, and holding devices are discussed. (GE)

**28738** FERNBEDIENUNGSGERAETE ZUM ARBEITEN HINTER SCHUTZWAENDEN. Parallelmanipulatoren in Teleskopbauart, Anforderungen. Entwurf. (Remote Handling Devices for Use Behind Shielding Walls. Telescopic Master-Slave Manipulators, Requirements. Draft). Berlin; Beuth (Nov 1974). 7p. 4 tabs.

Basic requirements and criteria of application: basic design, scope, capacity, no-load resistance, elastic deformation, own-weight compensation, gastightness, materials, constructional features, assembling, maintenance, electrical equipment, delivery specifications, acceptance tests are reviewed. (GE)

**28739** DATA ACQUISITION AND CONTROL OF MULTICHANNEL ANALYZERS WITH THE IBM SYSTEM/7 IN THE HOT CELLS OF THE KERNFORSCHUNGSANLAGE JUELICH. Kuehnlein, W. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)); Weichsel, R. (IBM Deutschland, Bonn-Bad Godesberg (F. R. Germany)). IBM Nachr.; 25: No. 225, 83-91(1975). (In German). 10 figs.; 6 refs.

The profitability of a reactor depends on the efficient utilization of the fuel contained in the fuel elements. Fuel elements are developed and tested by irradiation in research reactors and tests in "hot cells". An important part is played by gamma spectrometric measurements to determine the amount and distribution of fission products. As the specimen are irretrievable and can only be transported to the place of measurement by extensive and complicated sluice and transport processes, the gamma spectroscopic measurements have to be carried out extremely scrupulously, and the measured values have to be recorded with great precision. This is why in the "hot cells" of the "Institut fuer Reaktorwerkstoffe" the measured values are transmitted over a line network from several measuring points to an IBM system/7, where the formal correctness of the data is checked. The spectres are evaluated on an IBM system/370-165 in the "Zentralinstitut fuer angewandte Mathematik". (auth)

## Transportation

*Refer also to abstract 29626.*

**28740** (ARH-3113) SAFETY ANALYSIS REPORT FOR PACKAGING TYPE LLD-1 SHIPPING CONTAINER. Herbolsheimer, J. A. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 11 Jun 1974. Contract AT(45-1)2130. 19p. Dep. NTIS $4.00.

The safety of LLD-1 shipping containers used at the Savannah River Plant (SRP) and the Atlantic Richfield Hanford Co. (ARHCO) are compared on the basis of O-ring material integrity, overall design similarity, and safety of loadings. ARHCO ships Pu metal, $^{239}PuO_2$, and $^{241}AmO_2$ in the LLD-1. It is concluded that the ARHCO-controlled LLD-1 shipping containers will provide a degree of safety equivalent to that of SRP LLD-1's. (LCL)

**28741** (ARH-3113(Suppl. 1)) SAFETY ANALYSIS REPORT FOR PACKAGING TYPE LLD-1 SHIPPING CONTAINER. Hoover, D. A. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 24 Oct 1974. Contract AT(45-1)-2130. 7p. Dep. NTIS $4.00.

Additional information is presented on the pressurization of the 2R vessel in the LLD-1 shipping container by expansion of the contained air and other gases under specified thermal expansion conditions. This information applies to the shipment of $^{239}PuO_2$. The safety analysis showed that: the pressure increase in the 2R Vessel is within the capacity of the vessel; there appears to be no possible leakage of radioactivity from the 2R Vessel during transport; and in over 20 years experience with the LLD-1 shipping package, no leakage has occurred. (LCL)

**28742** (ARH-3113(Suppl.2)) SAFETY ANALYSIS REPORT FOR PACKAGING TYPE LLD-1 SHIPPING CONTAINER. Supplement 2. Hoover, D. A.; Kelso, W. H. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 4 Dec 1974. Contract AT(45-1)-2130. 17p. Dep. NTIS $4.00.

This supplement provides information on the O-ring seal of the inner container (2R Vessel) of the Type LLD-1 shipping container under 700 psig pressure. Tests indicate that the inner container of the Type LLD-1 shipping container, when sealed with a Silicone O-ring, Porter Seal Company A-246 or equal, will not release its contents under conditions of transport described in the Atomic Energy Commission Manual Chapter 0529, Annexes 1 and 2. (TFD)

**28743** (NEDO-10084-1) DESIGN AND ANALYSIS REPORT: IF 300 SHIPPING CASK. (General Electric Co., San Jose, Calif. (USA). Nuclear Fuels Dept.). Feb 1973. vp. General Electric Co., San Juan, CA.

This report describes the design and safety analysis of the General Electric IF 300 Irradiated Fuel Shipping Cask. The cask body is a depleted uranium shielded and stainless steel clad, annular cylinder, closed at one end. Fuel is loaded through the top end and closure is accomplished using a bolted and sealed head. The head shielding is similar to the cask body. The cask is suitable for the shipment of all types of light-water-moderated reactor fuels. As such, permissible cask contents are based on limiting fuel parameters rather than individual fuel types. For purposes of identification, these design basis fuels are divided into two generic classes, BWR and PWR. The design basis fuel parameters in each class meet or exceed existing fuel parameters. (TFD)

**28744** (SAND-75-0276) AIR DROP TEST OF SHIELDED RADIOACTIVE MATERIAL CONTAINERS. Waddoups, I. G. (Sandia Labs., Albuquerque, N. Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 17p. Dep. NTIS $4.00.

Two lead-shielded containers were dropped from 2000 feet onto hard prairie as a visible and easily understood demonstration of the ability of such containers to retain integrity under extremely adverse environments. The OD-1 cask, which weighs 16,300 lb (7410 kg), was used to ship and store spent fuel elements from an Oak Ridge research reactor. The B of E 83 container, which weighs 6,720 lb (3054 kg), was used in handling irradiated test capsules. Both are considered obsolete since they were not designed to survive the current fire requirements. Neither of the containers would have released their contents under this impact environment. (TFD)

**28745** (Y-DR-20) NUCLEAR CRITICALITY SAFETY ANALYSIS OF A 55-GALLON-DRUM FOAMGLAS CONTAINER. Thomas, J. T. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1969. Contract W-7405-eng-26. 19p. Dep. NTIS $4.00.

Mass limits for the fissile isotopes $^{235}U$, $^{233}U$, and $^{239}Pu$ have been determined for a proposed 55-gal-drum shipping container having Foamglas as a thermal insulator. The physical forms of the fissile materials considered were metal, oxides at an H/X atomic ratio of 0.4 and 3, and aqueous nitrate solutions having no excess nitrate. Recommended mass limits corresponding to transport indices from 0.1 to 2.0 are given. (auth)

# PARTICLE ACCELERATORS

**28746** PROCEEDINGS OF THE 1975 PARTICLE ACCELERATOR CONFERENCE: ACCELERATOR ENGINEERING AND TECHNOLOGY, WASHINGTON, DC, MARCH 12–14, 1975. IEEE (Inst. Electr. Electron.Eng.) Trans. Nucl. Sci.; NS-22: No, 3, 905-1992 (Jun 1975).

261 papers were presented on the design, development, and operation of particle accelerators, storage rings, and their components. Separate abstracts for 67 of these papers have previously appeared in Nuclear Science Abstracts (NSA), and can be located by the conference number (CONF-750335) appearing in the Report Number Index of NSA. Separate abstracts were prepared for NSA for an additional 192 papers; abstracts for 90 of these will also

*For abstracts of individual papers see: 27893, 28759–28798, 28809–28871, 28873–28892, 28899–28927, 28931–28960, and 28970–28978.*

## Design, Development, and Operation

**28747** (CONF-740372-) UNDERGROUND TOPOMETRY. Study Seminar, Geneva, Switzerland, March 5–6, 1974. (Institut National des Sciences Appliquees (INSA), 69 - Villeurbanne (France); European Organization for Nuclear Research, Geneva (Switzerland)). 1974. vp. (In French).

Eight papers were presented at the conference. The first five papers deal with the general instrumentation and techniques of underground topography; the remaining three deal with the application of these techniques and instrumentation to the construction of the CERN underground 400-GeV synchrotron. A separate abstract was prepared for each of the latter three papers. (JSR)

*For abstracts of individual papers see: 28748–28750.*

**28748** (CONF-740372-, pp 123-166) PROBLEMS OF UNDERGROUND TOPOMETRY AT CERN. Menant, E. (CERN, Geneva). 1974. (In French).

From study seminar on underground topometry; Geneva, Switzerland (5 Mar 1974).

In underground topometry.

The basic principles used in the determination of the topography for the CERN synchrotron and the permissible tolerances in the construction of the tunnel are outlined. The techniques used in the underground work are described, and the materials and instruments used in the construction are discussed. The results obtained from the underground topographic measurements are reported. The calculations made and the results obtained are outlined. (JSR)

**28749** (CONF-740372-, pp 167-190) AUTOMATION OF THE GYROSCOPE. Bois, D.; Menant, E.; Olsfors, J. (CERN, Geneva). 1974. (In French).

From study seminar on underground topometry; Geneva, Switzerland (5 Mar 1974).

In underground topometry.

The principles of the gyroscope are summarized, and the experience obtained in the use of a manual gyroscope in making the required underground measurements is discussed. Research on methods of automating the gyroscope is reported, and the automatic gyroscope constructed is described. Its operational principles are considered, with an outline of the calculations given. (JSR)

**28750** (CONF-740372-, pp 193-217) RESULTS OBTAINED IN THE UNDERGROUND GEODESY OF THE 400 GeV SYNCHROTRON (SPS). Gervaise, J. (CERN, Geneva). 1974. (In French).

From study seminar on underground topometry; Geneva, Switzerland (5 Mar 1974).

In underground topometry.

The stringent demands made on the geodesic precision in the boring of the tunnel for the CERN synchrotron are emphasized. The results obtained in the boring of the tunnel and the precision control necessary to avoid deviations from the required tunnel alignment are discussed. The positioning of the accelerator functional elements is considered. (JSR)

**28751** (CONF-750824-13) ACCELERATORS FOR HEAVY IONS. Martin, J. A. (Oak Ridge National Lab., Tenn. (USA)). 1975. 10p. Dep. NTIS $4.00.

From 7th international conference on cyclotrons and their applications; Zurich, Switzerland (19 Aug 1975).

The use of heavy ion accelerators in nuclear physics, nuclear chemistry, atomic physics, and in material sciences studies is rapidly increasing. A review is given of the present and developing scene in heavy ion accelerator concepts and technology. The area of applicability of various methods, likely avenues of future development, and the trends of future requirements are discussed. (auth)

**28752** (JINR-9-7148) PROSPECTS IN STUDIES ON RELATIVISTIC NUCLEAR PHYSICS AT THE JINR HIGH ENERGY LABORATORY. Considerations on the Accelerating Complex Development. Baldin, A. M.; Beznogikh, Yu. D.; Voevodin, M. A.; D'yachkov, E. I.; Zel'dovich, A. G.; Zinov'ev, L. P.; Issinskij, I. B.; Kazanskij, G. S.; Kolpakov, I. F.; Makarov, L. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 57p. (In Russian). INIS.

Consideration is given to construction of a superconducting accelerator of relativistic nuclei, a "nucleotron," with energies of 20-25 GeV per nucleon, which may be installed in an existing synchrophasetron at JINR. Preliminary parameters for the different nucleotron parts and possible orientation studies are presented. (tr-auth)

**28753** (UCRL-Trans-1522) STUDIES FOR DIMENSIONING A HEAVY ION LINEAR ACCELERATOR OF THE WIDEROE TYPE (DIMENSIONING OF THE FOUR WIDEROE SECTIONS OF THE UNILAC ACCELERATOR). Kaspar, K. (Gesellschaft fuer Schwerionenforschung m,b,H., Darmstadt (F,R, Germany)). Oct 1973. Translation of GSI-73-10. 92p. Dep. NTIS $7.75.

The UNILAC accelerator, constructed in the neighborhood of Darmstadt by the Society for Heavy Ion Research, is a high-frequency linear accelerator which permits all atoms up to elevenfold positively charged uranium ions to be accelerated to variable final energies of 3,5 to 8,5 MeV/nucleon. The fundamentals of dimensioning for the construction of the Wideroe section in the UNILAC accelerator are discussed. Within the framework of this task, high-frequency technology investigations were carried out, in addition to the various investigations and computations required for the construction of the accelerating structure, and were concluded with extensive model measurements. The most important basic concepts, computational and measuring techniques, and test results used in dimensioning the Wideroe section are presented. A short overview of the construction of the entire UNILAC accelerator and the operation of its most important components is also given. (auth)

**28754** RESONANCE OF $^{12}C(p, p)^{12}C$ AT 4.8 MeV AS CALIBRATION CONTROL FOR LOW ENERGY ACCELERATORS. Lopex, J. L.; Calvillo, J.; Varela, A.; Jimenez, Y. F. Rev. Mex. Fis., Supl. Fis. Apl.; 23: FA7-FA12(1974). (In Spanish).

The neutron thresholds in $^{7}Li$(1880.60 keV) and $^{27}Al$(5796.9 keV) were compared with an intermediate resonance energy of $^{12}C(p, p)^{12}C$ (4.8 MeV. As carbon appears in almost any blank, the resonance at a bombardment energy of 4794.0 keV is suggested as an easy point to test the calibration. (tr-auth)

**28755** NEW COLLISION LABORATORY. Rickards, J.; Barragan, A.; Andrade, E.; Dorantes, J.; Lopex, K.; Mercado, F.; Dacal, A.; de Lopez, M. E. O.; Mazari, M. (Universidad Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 23: FA55-FA73(1974). (In Spanish).

A recently installed laboratory for the study of atomic collisions and applications of nuclear techniques is described. The principal instrument is a 700 keV Van de Graaff accelerator with a 3.75 amu-MeV switching magnet. The facilities include a scattering chamber, a magnetic spectrograph, pulse electronics, and an on-line computer. The accelerator calibration and some preliminary results on microanalysis by backscattering and X-ray excitation are described. (auth)

**28756** CONVERSION OF AN ORDINARY CYCLOTRON INTO A VARIABLE-ENERGY ACCELERATOR. Wakatsuki, T.; Takeda M.; Kato, S.; Tokahashi, N.; Shibata, T.; Itahashi, T.; Aoki, Y.; Okada, K.; Kaura, J.; Yamagata, T. (Osaka Univ., Toyonaka (Japan). Dept. of Physics). Nucl. Instrum. Methods; 126: No. 3, 349-354(15 Jun 1975).

The Osaka University 110 cm ordinary cyclotron, capable of accelerating protons, deuterons, and $\alpha$ particles to energies of 5.7 MeV, 11.4 MeV, and 22.8 MeV, respectively, was converted into a variable-energy accelerator. Incorporation of concentric trim coils and of a variable-frequency resonator system are the main features of the conversion. The energies obtainable from the remodeled machine are 2.2-10 MeV for protons, 4.5-13 MeV for deuterons, 7.0-26 MeV for $^{3}He$ particles, and 9.0-26 MeV for $\alpha$ particles. (auth)

**28757** HIGH-VOLTAGE 500-kV CABLE INPUT FOR AN ELECTRON ACCELERATOR WITH A THERMIONIC CATHODE.

Vainshtein, L. A.; Vlasov, M. A.; Glebov, V. V.; Novichkov, D. N. (All-Union Electrotechnical Inst., Moscow). Instrum. Exp. Tech.; 17: No. 6, 1565-1568(1974).

Translated from Prib. Tekh. Eksp.; No. 6, 19-22(1974).

The construction of a high-voltage vacuum electrical input lead for an electron accelerator incorporating a thermionic cathode is presented. The results of electrical-strength tests applied to this input lead show that it is suitable for use with accelerating voltages up to 500 kV. (auth)

**28758** BESCHLEUNIGER. (Accelerators). Daniel, H. Teubner Studienbuecher Physik. Stuttgart; Teubner (1974). 215p. (In German).

76 figs.

This book has been compiled from lectures held in the Technical University of Munich. The lecture character was to be retained in the book as far as possible. This means that more importance is attached to comprehensibility than to completeness. Important phenomena of accelerator operation are explained in the light of selected examples. There are no attempts made to treat a specific phenomenon in all its possible contexts. The basic principles of particle acceleration and particle guidance in electromagnetic fields and the main accelerator types realized so far are treated in more detail. (auth)

**28759** BASIC RESEARCH IN THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION. Teem, M. M. (Energy Research and Development Administration, Washington, DC). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 910-917(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Energy Research and Development Administration (ERDA) is responsible for a unified approach to planning, management, and funding of six primary activity areas: (1) fossil energy; (2) nuclear energy; (3) environment and safety; (4) conservation; (5) solar, geothermal, and advanced energy systems; and (6) national security. Basic research supported by ERDA should be evaluated with respect to the importance of new knowledge produced, but should also be able to contribute to applied needs in all six areas. Heavy ion research has benefited several areas, contributing to materials studied of simulated neutron damage, ion implantation for semiconductor and memory device fabrication, and the use of accelerated beams in medical research, radiography for example. ERDA has budgeted FY 1976 funds for two heavy ion facilities, the major facility at Oak Ridge and the additional construction at the SuperHILAC, Berkeley. It is recommended that future budgets provide for a 15 GeV positron electron colliding beam facility (PEP) at SLAC, full scale models of superconducting magnets for a proposed 200 GeV proton-proton colliding beam facility at BNL, and, as long term goal, a several thousand GeV accelerator at Fermilab. (PMA)

**28760** OPERATING RESULTS FROM FERMILAB. Livdahl, P. V. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 929-935(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The work of the entire Fermi National Accelerator Laboratory is reported, including the status of proposals and experiments, the scope of the research program, and the performance of the accelerator. The status of facility components are also discussed, covering: (1) the main accelerator; (2) the preaccelerator; (3) the linac; (4) the booster system; and (5) the extraction and switchyard system. Two advanced accelerator projects are reviewed, an energy saver/doubler magnet system and the development of a superconducting power transmission line. (PMA)

**28761** CONTRIBUTIONS OF THE ACCELERATOR FRATERNITY TO THE SOLUTION OF ENERGY PROBLEMS. Blewett, J. P. (Brookhaven National Lab., Upton, NY). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 936-939 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A brief summary is presented of the present situation in the field of energy production and consumption. Particular attention is given to areas where accelerator builders are particularly active. This includes fusion, solar energy, and energy storage and transmission. A few leaders in these fields who have been active in building or using particle accelerators are identified. In conclusion, a few problems are mentioned which could be assisted toward solution by the talents of the accelerator fraternity. (auth)

**28762** PULSERAD 1480: A 9 MV PULSED ELECTRON ACCELERATOR WITH AN INTENSELY FOCUSED BEAM. Champney, P.; Spence, P. (Physics International Co., San Leandro, CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 970-974(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Pulserad 1480 is a flash x-ray generator designed to take time-synchronized radiographs through large objects containing high-atomic number materials moving at high velocity. A pulsed 200 kA beam of 7 MV (mean energy) electrons impinges on a tungsten target, producing an x-ray dose of approximately 400 R for 150 ns at one meter from the anode. The components of the accelerator are described, including the generator, the transmission lines, the prepulse isolation switch, and the tube assembly. The diode impedance and pinch characteristics are discussed. (PMA)

**28763** VEBA RELATIVISTIC ELECTRON ACCELERATOR. Parker, R. K.; Ury, M. (Naval Research Lab., Washington, DC). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 983-988(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The VEBA high-current, relativistic electron accelerator was designed and constructed at NRL for applications in the study of high-power microwave sources. To meet the requirements of this study, the accelerator was designed for operation in either a short (60 n sec) or long (2.2 mu sec) pulse mode. The short-pulse mode has been in operation for nearly two years and has proven to be an extremely reliable design. The design of the long-pulse mode is now complete and component fabrication will soon be underway. The pulse-forming network in the short-pulse mode is an unbalanced, water Blumlein with an output impedance of 9.2 OMEGA. The Blumlein is pulse charged by a 17 stage Marx generator which has a series capacitance of 29.4 nF. By transmission along a tapered coaxial line, the output pulse is transformed to 20 OMEGA, and the voltage developed across a matched load increases to a maximum of 2.3 MV. The proposed conversion to the long-pulse mode will require the Blumlein and transformer sections be removed and the diode assembly be attached directly to the oversized Marx tank. The direct coupling between the Marx and the Blumlein will then be replaced by two nested water capacitors, which are shunted by spiral inductors. When coupled in series with the Marx, this output filter will form a three-section, voltage-fed, Guillemin (type A), pulse-forming network with a characteristic impedance of 40 OMEGA and a maximum output voltage of 0.9 MV. (auth)

**28764** COLLECTIVE ACCELERATION OF PROTONS AND HELIUM IONS IN THE GARCHING ERA. Schumacher, U.; Andelfinger, C.; Ulrich, M. (Max-Planck-Institut fur Plasmaphysik, Garching, Ger.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 989-991(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Collective acceleration of hydrogen and helium ions by relativistic electron rings was achieved in the Garching ERA. The ERA features fast electron ring compression and smooth magnetic expansion acceleration. Acceleration of the confined ions was determined by the inertia increase with the load of the rings and by nuclear track recording. (auth)

**28765** EXPERIMENTAL INVESTIGATION OF LINEAR-BEAM COLLECTIVE ION ACCELERATION IN VACUUM. Zorn, G. T.; Kim, H.; Boyer, C. N. (Univ. of Maryland, College Park). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1006-1008(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Preliminary experimental results of collective ion acceleration using a linear beam from the University of Maryland Electron Ring Accelerator injector are presented. Neutron yield of $10^9$ neutrons/pulse from Cu(p,n)Zn reactions are observed. From the Q value of the reaction, the energy of the proton must be above 4 MeV. The number of protons per pulse is estimated to exceed $10^{13}$. (auth)

**28766** NEW COLLECTIVE EFFECT, HIGH FLUX ION ACCELERATOR. Goldenbaum, G. C. (Univ. of Maryland, College Park). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1009-1012(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A new type of accelerator capable of producing a large flux of medium energy ions is discussed. The accelerator contains a charge neutral plasma in a magnetic field. Electron currents parallel to B vector heat the plasma electrons to an average energy kT/sub e/ by the Joule process. The electrons try to escape from the plasma into an adjacent vacuum region along the magnetic field lines. In doing so they create a charge separation electric field which collectively accelerates the ions to energies greater

than or equal to 10 kT/sub e/. The large resistivity necessary to obtain both the rapid heating and impedance matching to high power sources results from electron streaming instabilities in the plasma. Feasibility is investigated using a one dimensional, time dependent fluid model. In this model, a realistic circuit is coupled to the plasma electrons. The resultant plasma heating and expansion are numerically followed in time and space. These calculations seem to imply that present day technology utilizing high voltage Blumlein transmission lines (Z approximately equal to 1OMEGA) seem capable of creating a 10 MeV proton stream with energy greater than 10 kJ, and equivalent current density greater than 10 kA/cm$^2$. (auth)

**28767** TRACE I, A TRANSFORMER-CHARGED ELECTRON BEAM GENERATOR. Rohwein, G. J. (Sandia Labs., Livermore, CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1013-1015(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A transformer-charged electron beam generator was developed. The system is designed to operate with up to 500 kV on a water-dielectric pulse-forming line (PFL) and to generate a 100 kA, 30 ns electron beam. The transformer charging supply replaces a 12-stage Marx generator and reduces the size, weight, and complexity of the system. It also eliminates the need for a large insulating-oil supply. A description of the physical features of the machine is included along with a discussion of the electrical characteristics of the system. (auth)

**28768** PERFORMANCE AND CHARACTERISTICS OF THE IUCF INJECTOR CYCLOTRON. Pollock, R. E.; Schwandt, P.; Hicks, J. W. (Indiana Univ. Cyclotron Fac., Bloomington). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1049-1051(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Indiana University Cyclotron Facility (IUCF) will produce variable-energy light ion beams of energy up to 220 $Q^2/A$ MeV. The three stage accelerator consists of a 600 kV dc ion source terminal, an injector cyclotron of nominal 16 $Q^2/A$ MeV, and a main stage cyclotron. The two cyclotrons are of isochronous separated-radial-sector design, and are similar except for overall scale. The project was funded in 1968 and will begin operation during 1975. The first two stages were assembled in a temporary location and operated for a few months in 1972. Following relocation and reconstruction in the accelerator laboratory, the first two stages have been in use with internal beam since November 1973 and with extracted beam since October 1974. The current status of the injector cyclotron design and some of its performance characteristics as predicted and as observed in beam development studies are reported. (auth)

**28769** DOUBLE PASS LINEAR ACCELERATOR: REFLEXOTRON. Schriber, S. O.; Heighway, E. A. (Chalk River Nuclear Labs., Ont.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1060-1064(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Measurements of energy spectra and percentage beam transmissions are given for an S-band linear accelerator through which the electron beam passes twice, in opposite directions. Results are presented for two magnet reflecting systems which have energy acceptance windows, DELTA E/E, of 2 percent and 16 percent, where E is the output beam energy after the first pass through the accelerator. For a first pass beam energy of 8 MeV the second pass energy could be varied from 3 MeV to 16 MeV by changing the separation between the accelerator and the magnet system. The corresponding full-width half-maximum energy spreads were 1.6 MeV and 0.7 MeV respectively. The system transmission was 35 percent first pass (unbunched injected beam) and approximately 100 percent second pass. (auth)

**28770** MICROTRON USING A SUPERCONDUCTING ELECTRON LINAC. Axel, P.; Hanson, A. O.; Harlan, J. R.; Hoffswell, R. A.; Jamnik, D.; Sutton, D. C.; Young, L. M. (Univ. of Illinois, Urbana). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1176-1178(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The superconducting linac of the 6 pass microtron (MUSL-1) was operated at 4.2 K for about 3 years with an energy gain of 2 MeV/meter. The duty factor was limited to about 50 percent by thermal effects. A new helium liquefier supplies more than the 13 liters per hour required to operate the linac continuously at its maximum duty factor. The system can supply 5 mu a of electrons with energies up to 19 MeV and has been operated on a 24 hour per day schedule for nuclear physics experiments. A larger system (MUSL-2), having a surplus 3 MeV Van de Graaff as an injector and a 6 meter superconducting accelerator section, is being assembled in another area. Although the installation is not yet complete, microwave tests indicate that the section can be operated continuously with an energy gain of 13 MeV for an input power of about 10 watts. For the initial operation of MUSL-2, the 6 pass hardware from MUSL-1 will be used to recirculate the electron beam through the new linac section to a final energy of 60 MeV. (auth)

**28771** ACCELERATED PARTICLES IN RADIATION ONCOLOGY. Heusinkveld, R. S.; Boone, M. L. M.; Conner, W. G. (Univ. of Arizona Medical Center, Tucson). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1211-1215(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The history of the use of particle accelerators for radiotherapy is reviewed, including the various types of radiation and their characteristics. A conservative estimate of the percentage of irradiated cancer patient cured is 50 percent, and it is estimated that improved radiotherapy could save about 60,000 lives per year. The future of radiotherapy in the treatment of tumors is projected. (PMA)

**28772** INDUSTRIAL APPLICATIONS OF SMALL ACCELERATORS. Duggan, J. L. (North Texas State Univ., Denton); Morgan, I. L. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1216-1228.

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Current practical applications of small accelerators are summarized. These include: trace element studies with both neutron activation analysis and charged particle induced x-rays, accelerator produced neutron well logging techniques, and accelerator-based research associated with the controlled thermonuclear research program. A rather extensive bibliography is included in all three areas. (152 references) (auth)

**28773** RECENT PROGRESS ON SLED, THE SLAC ENERGY DOUBLER. Farkas, Z. D.; Hogg, H. A.; Loew, G. A.; Wilson, P. B. (Stanford Linear Accelerator Center, CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1299-1302(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The recent discovery of psi particles has added further incentive to the search for ways of increasing the beam energy at SLAC. Several schemes for achieving higher energies have been explored in recent years. The system which has become known as SLED (SLAC Energy Doubler) has received ERDA approval for gradual installation, using Accelerator Improvement Funds. As presently conceived, SLED has the advantage that it will not increase the average power consumed by the accelerator, and is therefore compatible with national energy-conservation goals. Peak rf power will be enhanced at the expense of rf pulse length, so that the accelerator will deliver shorter pulses of higher-energy electrons with a duty cycle a factor of ten lower than at present. The system is described, and it is shown that SLED raises the accelerator peak energy by 40 percent if the present 2.7 mu s rf pulse length is used. The energy increase is 80 percent if the pulse length is extended to 5 mu s. Performance at both pulse lengths is discussed. (auth)

**28774** WIDE DYNAMIC RANGE 10 MeV HIGH CURRENT ELECTRON LINEAR ACCELERATOR. Haimson, J.; Mecklenburg, B.; Valencia, V. (Haimson Research Corp., Burlington, MA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1303-1306(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The salient features of a new high power linear accelerator system are described. This machine combines a 300 kV dc accelerator, constructed for operation with pulsed currents in excess of 2A, with a single section 10 MeV accelerator waveguide so that given levels of high peak current may be maintained over a wide range of beam energies. (Previous technology required rf phase and power adjustment to a second accelerator section.) The accelerator waveguide incorporates a suppressed phase oscillation buncher designed so that a loss of terminal electric field strength, caused by a large reduction of input rf power to reduce beam energy, may be accurately compensated by an increase in potential of the dc accelerator, thus maintaining the capture efficiency of the waveguide. Reduction of space charge forces due to h-v injection, and avoidance of dual section operation, prove to be major operational advantages. The 20 MW rf transmitter and the overall beam centerline are described, and operating performance and equipment photographs are presented. (auth)

**28775** BATES LINAC OPERATIONAL EXPERIENCE. Sargent, C. P.; Turchinetz, W.; Weaver, J. N. (Massachusetts Inst. of Tech., Middletown). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1341-1342(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Accelerator operation during the first year of scheduled beam to physics experiments is described. Some details of the gun, rf, water, vacuum, control and monitoring systems are reviewed with reference to performance and reliability. (auth)

**28776** COMPARISON OF STANDING WAVE ACCELERATORS OPERATING IN THE 1pi/3 AND pi/2 MODES. Schriber, S. O. (Atomic Energy of Canada, Ltd., Chalk River). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1343-1349(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Calculations of fields in standing wave accelerators operating in the 2pi/3 and pi/2 modes were made using a set of RLC coupled loop circuits to determine equilibrium current solutions. These results were compared to experimental on-axis field measurements in an S-band accelerating structure. Tolerances of the two systems to frequency and coupling-constant differences are discussed, as well as tolerance to operation slightly off-resonance. All results indicate that the pi/2 mode is significantly less sensitive to construction and operational differences. (auth)

**28777** REVIEW OF MESON FACTORIES. Michaelis, E. G. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1385-1396(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The development of meson factories is briefly summarized. Present facilities are described and compared with the design goals they set out to meet. Further developments and limitations are discussed. (63 references) (auth)

**28778** S.I.N. RING CYCLOTRON AFTER ONE YEAR OF OPERATION. Joho, W. (Swiss Inst. of Nuclear Research, Villigen). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1397-1401(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The 590 MeV isochronous ring cyclotron produced its first extracted proton beam in January 1974. One year later, the situation is as follows: Two external targets with a total of six secondary pion beam lines and one neutron line are operational, and a number of experiments with medium energy pions were performed. The superconducting muon channel is operating successfully and produces the highest muon fluxes ever recorded. Transmission through the ring cyclotron is more than 95 percent. Typical currents on the targets are 5 mu A, the maximum being 25 mu A. (auth)

**28779** PRODUCTION OF SIMULTANEOUS, VARIABLE ENERGY BEAMS FROM THE TRIUMF CYCLOTRON. Richardson, J. R.; Blackmore, E. W.; Dutto, G.; Kost, C. J.; Mackenzie, G. H.; Craddock, M. K. (Univ. of British Columbia, Vancouver). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1402-0407(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

An extracted beam at the design energy of 500 MeV was obtained at TRIUMF in December, 1974. Later, beams of varying energies between 180 and 520 MeV were extracted down beam line 4, and further work resulted in the simultaneous extraction of a 506 MeV beam down beam line 1 and variable energy beams down line 4. In order to reduce initial activation of cyclotron components, time average beams were restricted to 100 nA, but 12 mu A in a pulsed beam was very easily obtained at 500 MeV. Without optimization of the injection conditions and without use of the harmonic trim coils, an energy spread (full width) of 2.5 to 3.0 MeV was observed. Ordinarily, the macro-duty factor was 100 percent, and the micro-duty factor corresponded to a 5 ns pulse every 44 ns. The transmission to 500 MeV is consistent with the expected loss due to gas stripping. (auth)

**28780** NEVIS SYNCHROCYCLOTRON BEAM STATUS REPORT. Storm, D. W.; Cohen, R. C.; Dugan, G.; Sachs, A. M.; Rainwater, J.; Au, Y.; Hawrylak, R. A.; Shill, J.; Tinta, F. G. (Columbia Univ., NY). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1408-1410(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In January 1975, the first full energy (570 MeV) beam was obtained at the Nevis Synchrocyclotron. Measurements of beam current at small radius indicated a beam current of 12 mu A for 300 pulse/s operation. The vertical properties of the beam were measured, and some information on the radial width was obtained. A brief review of the design features of the Nevis Synchrocyclotron is given, and beam studies and current status of the accelerator are described. (auth)

**28781** STATUS OF THE VICKSI HEAVY ION ACCELERATOR. Busse, W. (Institut fuer Kernforschung, Berlin); Efken, B.; Hilsher, D.; Homeyer, H.; Lettau, H.; Lindenberger, K. H.; Mahnke, H. E.; Maier, K. H.; Ziegler, K.; Anderberg, B.; Hansen, P.; Holm, S.; Lindback, S.; Malm, B.; Harms-Ringdahl, L.; Rohlin, J.; Susini, A. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1643-1646(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The heavy ion accelerator combination VICKSI being built at the Hahn-Meitner-Institute in Berlin consists of a 6-MV Van de Graaff accelerator as injector into a 4 sector cyclotron with a mass energy product of 100. The primary design goal of this accelerator combination is 200 MeV for carbon to argon ions. The Van de Graaff, including ion source and high voltage terminal, is undergoing major reconstruction. The beam matching and transport system between the two accelerators, comprising a stripper and two bunchers, was designed. The rf system is under test with low power. The new building for the cyclotron is completed, except for interior work. The anticipated date for first beam injection into the cyclotron is November 1976. (auth)

**28782** CHALK RIVER HEAVY ION SUPERCONDUCTING CYCLOTRON. Hoffman, C. R.; Bigham, C. B.; Fraser, J. S.; Heighway, E. A.; Hulbert, J. A.; Ormrod, J. H.; Schneider, H. R. (Chalk River Nuclear Labs., Ontario). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1647-1650(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A detailed study of an isochronous cyclotron as an energy booster accelerator for the Chalk River 13 MV MP Tandem Van de Graaff was undertaken. The cyclotron is intended primarily for heavy ions, but would accelerate all ions from $Li^{3+}$ to $U^{33+}$ to at least 10 MeV/u. NbTi superconducting coils, supplemented with cylindrical iron poles, provide an average magnetic field of approximately 5T out to the extraction radius (0.65 m). Four saturated iron sectors with spiral edges provide focusing. Bunched ions are injected from the Tandem into the cyclotron midplane and stripped at the innermost orbit. An eight gap spiral edged rf structure provides 0.6–0.8 MV of accelerating voltage per turn. Electrostatic deflection initiates single turn extraction of the beam. (auth)

**28783** GANIL: A PROPOSAL FOR A NATIONAL HEAVY-ION LABORATORY. (GANIL Study Group, Orsay, France). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1651-1654(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Under the control of the French Atomic Energy Commission and of the National Institute of Nuclear and Particle Physics, an accelerator system for heavy ions is being studied. The heart of this system consists of two identical conventional separated-sector cyclotrons K equals 400 (SSC 1 and SSC 2); at the output of SSC 1, ions are stripped through a foil, after which highly charged ions are selected and injected into SSC 2. The injection into SSC 1 will be achieved by a small compact cyclotron or by a 1 MV electrostatic accelerator. As the required beam must be intense and precise (energy resolution and emittance), special attention was paid to careful matching of the three stages of acceleration in transverse and longitudinal planes, taking into account space charge forces as well as electric and magnetic defects. A set of parameters for the two main machines and their injectors is given. (auth)

**28784** MODIFICATION OF THE ARGONNE FN TANDEM. Yntema, J. L.; Billquist, P. (Argonne National Lab., IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1659-1661(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Argonne FN tandem now uses Pelletron chains for its charging system and a closed corona system for the voltage distribution along the column. This change improved the machine stability significantly. The maximum voltage on the terminal is now 9.8 MV, compared to 8.6 MV attainable previously in normal operation. The voltage fluctuations in the terminal decreased by an order of magnitude. (auth)

**28785** DESIGN OF A 320 kV ION ACCELERATOR FOR MULTIPLY CHARGED HEAVY IONS. Bannenberg, J. G.; Boerboom,

A. J. H. (Instituut voor Atoom- en Molecuulfysica, Amsterdam). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1675-1678(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

An accelerator for multiply charged ions with a terminal voltage of 320 kV was developed. A pulsed cold cathode P.I.G. ion source, with titanium cathodes and side extraction, is immersed in a magnetic field to analyze and focus the beam into the entrance aperture of the post accelerating column. Matrix calculations of the ion optics are given. After the accelerator, the beam can be focussed with an electrostatic triplet into a gas cell. The charge exchanged beam is analyzed in a magnet provided with several exit gates for the respective charge states. (auth)

**28786** UPGRADING THE ARGONNE 4-MV DYNAMITRON. Mooring, F. P.; Langsdorf, A. Jr.; Amrein, R. L. (Argonne National Lab., IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1726-1729(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Recently a new type of accelerator tube, made entirely of ceramic and metal and containing no organic material, was installed in the Argonne 4-MV Dynamitron. Instead of being cantilevered from the base of the accelerator as was the old tube, the new tube is suspended from the main frame by a set of compact springs of unique design. Consequently, the main frame had to be strengthened against sidewise sway. The new structural members also markedly increased the shear strength of the frame. Previously ion-source assemblies were mounted directly on and their weight supported by the accelerator tube. Now the weight of each source is carried by the terminal frame, and provisions were made for aligning each source to the tube. To provide space for a new source assembly which incorporates mass analysis, various electronic circuits within the terminal were relocated and the terminal wiring was rerouted. The accelerator performed well since the modifications. (auth)

**28787** INJECTOR CYCLOTRON FOR CYCLONE. Jongen, Y.; Ryckewaert, G. (Laboratoire de Cyclotron, Louvain-la-Neuve, Belgium). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1732-1735(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A heavy ion facility for CYCLONE (Belgium) is described. It consists of an injector cyclotron, able to accelerate heavy ions to a K value of 70 MeV $Q^2/A$, with an upgrading possibility of 100 MeV $Q^2/A$. Expected intensities are large. Some design aspects are described which allow the cost of the project to be quite low. (auth)

**28788** ACCELERATOR FOR THE FUSION PROGRAM. Sudan, R. N. (Naval Research Lab., Washington, DC). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1736-1742(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

There are several applications for accelerated particle beams for both confined and unconfined plasma fusion, but it is clear that the requirements imposed and types of accelerators needed are quite different for the two cases. The main applications in magnetic confinement systems for which accelerators have found use are: (1) plasma production; (2) plasma heating; (3) direct fusion between beam and target; and (4) magnetic field shaping by internal beam currents. Some specific applications are discussed, along with future requirements for accelerators dictated by the needs of the different schemes for achieving breakeven conditions. (PMA)

**28789** PERFORMANCE OF A MULTICAVITY RACETRACK MICROTRON. Froelich, H. R.; Manca, J. J. (University of Western Ontario, London). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22; No. 3, 1758-1762(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Measured characteristics of both the extracted beam and the beam within the accelerator are given for a racetrack microtron with a three-cavity accelerating structure. Final beam energies of 9 to 15 MeV with currents up to 30 mA were achieved by passing the beam six times through the cavities, and beam energies of 4.5 to 7.5 MeV with currents up to 60 mA were obtained after three traversals of the cavities. An improved injection system and magnetic guide field design are described, and the suitability of this type of machine for radiation therapy is considered. (auth)

**28790** INTENSE PULSED NEUTRON SOURCE FOR ARGONNE NATIONAL LABORATORY. Carpenter, J. M. (Univ. of Michigan, Ann Arbor); Price, D. L. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1768-1771(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A pulsed neutron source was designed for materials research in slow neutron scattering and radiation effects. The facility is based in its first phase on the ZGS 500 MeV Injector Booster Accelerator, which will produce $5 \times 10^{12}$ protons per pulse and will be modified for 60 Hz operation. In its second phase, a high intensity synchrotron will provide $5 \times 10^{13}$ protons per pulse at 60 Hz at 600 to 800 MeV. Neutrons are produced by spallation in two targets. A $^{238}U$ target, surrounded by three hydrogenous moderators, provides 12 neutron beams for slow neutron spectrometers. Peak thermal neutron fluxes of $1.5 \times 10^{15}$ and $10^{16}$ n/cm$^2$/s will be available in Phases I and II, respectively. Such pulsed beams will provide new capabilities for neutron scattering research, especially in the use of neutrons with energies up to 1 eV, which is beyond the capacity of the most advanced research reactors. A separate tungsten target for radiation effects studies provides fast neutrons (around 1 MeV) in 10 irradiation thimbles, with time-average fluxes around $3 \times 10^{13}$ and $3 \times 10^{14}$ n/cm$^2$/s in Phases I and II, respectively. The associated gamma-ray flux is extremely low. (auth)

**28791** SELF COLLIDING BEAMS ("MIGMA") AND CONTROLLED FUSION. Maglich, B. (Fusion Energy Corp., Princeton, NJ); Mazarakis, M.; Miller, R. A.; Nering, J.; Channon, S.; Powell, C.; Treglio, J. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1790-1793(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The idea of using colliding beams for fusion is nearly as old as is the interest in fusion as a source of power, but the problems of low reaction rate and high coulomb scattering initially seemed insurmountable. Some recent work done which attempts to overcome these problems is described. (auth)

**28792** HARD-ROCK TUNNELING USING PULSED ELECTRON BEAMS. Avery, R. T.; Keefe, D.; Brekke, T. L.; Finnie, I. (Univ. of California, Berkeley). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1798-1801(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Intense sub-microsecond bursts of energetic electrons cause significant pulverization and surface spalling of a variety of rock types. The spall debris generally consists of sand, dust, and small flakes. If carried out at rapid repetition rate, this technique appears promising for increasing the speed and reducing the cost of underground excavation of tunnels, mines, and storage spaces. The conceptual design features of a pulsed electron tunnel excavator, capable of tunneling approximately ten times faster than conventional drill/blast methods, is presented. (auth)

**28793** FEASIBILITY OF ACCELERATOR APPLICATION FOR PULSED MHD POWER GENERATION. Denno, K. (New Jersey Inst. of Tech., Newark). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1813-1816(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Prospects for pulsed electrical power output from an MHD self-excited accelerator driven generator is investigated. Feasibility is centered on exploring the magnitude of acceleration and energy conversion ratio in the accelerator channel subject to a spectrum of applied current impulses. Plasma conditions of moderate and high degree of ionizations are studied. (auth)

**28794** IMPLICATIONS OF HIGH BEAM CURRENTS FOR ACCELERATOR AND COMPONENT DESIGN. Morton, P. L. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1833-1837(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The need for higher currents has been a primary force in design and innovation since the invention of accelerators, and a substantial amount of attention continues to be directed toward this end. Some aspects of the influence this effort has had upon the design of accelerators and storage rings are reviewed. In order to permit proper coverage and to achieve clarity, it was necessary to limit the choice of topics for discussion and therefore to omit some of the many schemes used to achieve the present degree of success. These topics were arbitrarily selected from the following categories: (1) transverse interaction of a beam with its surroundings; (2) longitudinal interaction of a beam with its surroundings; and (3) influence of vacuum on high beam currents and colliding beam-beam interactions. (auth)

**28795** DESIGN OF THE ZERO GRADIENT SYNCHROTRON BOOSTER-II LATTICE. Crosbie, E. A.; Foss, M. H.; Khoe, T. K.; Simpson, J. D. (Argonne National Lab., IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1919-1921(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A 500 MeV booster was designed at the Argonne National Laboratory to increase the beam intensity from the Zero Gradient Synchrotron (ZGS). Many turns of $H^-$ ions from the 50 MeV linac will be injected into the booster and stripped to $H^+$ so that the ring will contain the maximum useful charge in each booster pulse. Several booster pulses will be injected into the ZGS to form one ZGS pulse. This machine is now under construction. (auth)

**28796** PROMISE OF HIGH ENERGY PHYSICS, WHY MORE ACCELERATORS. Weisskopf, V. F. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1948-1951(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A history of high energy particle physics, recent discoveries in the field, and the evolution of particle interaction theories are reviewed. Questions remaining in the theoretical picture are presented, and the possibility of obtaining the answers to these questions from higher energy machines is discussed. (PMA)

**28797** COLLECTIVE ACCELERATION IN LINEAR HIGH-CURRENT ELECTRON BEAMS. Kolomensky, A. A.; Likhachyov, V. M.; Yablokov, B. N. (Lebedev Inst. of Physics, Moscow). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1983-1987(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Experiments in collective methods of acceleration in linear beams were conducted on a two-beam high-current electron accelerator having the following parameters: energy-800 keV, pulse current-up to 30 kA, and pulse duration-40 ns (half-width). To obtain an absorption curve, oscillograms of current pulses incident in the foil and passing through it were integrated and the ratio charges determined. Absorption curves for electrons of 450 keV maximum energy passing through a waveguide of 60-cm length and through the tube are shown. (auth)

**28798** ELECTRON RING ACCELERATOR DEVELOPMENT. Barabash, L. S.; Ivanov, G. A.; Ivanov, I. N.; Dolbilov, G. V.; Zeldovich, A. G.; Kozhukhov, I. V.; Novikov, V. G.; Perelshtein, E. A.; Rubin, N. B.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1988-1992(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Recent investigations on collective electron ring ion accelerators are reviewed. Theoretical analyses are difficult because of the collective acceleration interactions, and the results presented are of an approximate character. The use of the collective accelerating method for heavy ions is attractive, since the accelerating field is not dependent on the type of ions. (PMA)

**28799** THE QUASIMONOENERGETIC PHOTON FACILITY AT THE GEISSEN 65MeV ELECTRON LINEAR ACCELERATOR. Kneissl, U.; Koop, E. A.; Kuhl, G.; Leister, K. H.; Weller, A. (Giessen Univ. (F. R. Germany). Abt. Grossgeraete (Angewandte Kernphysik)). Nucl. Instrum. Methods; 127: No. 1, 1-10(15 Jul 1975).

The method of the positron annihilation in flight is used to produce quasimonoenergetic photons of variable energy. The photon facility (8-40 MeV) at the Giessen accelerator is described. The positron production, the beam transport, and monitor system are discussed. The absolute calibrations and the $4\pi$ neutron detector used in $(\gamma,xn)$ reactions are explained. The performance of the facilities is demonstrated by test measurements of the total photoneutron cross sections $\sigma(\gamma,Tn)$ for $^{12}C$ and $^{16}O$. (auth)

**28800** A SURVEY OF THE FERMI LAB RESEARCH PROGRAM. Giacomelli, G.; Greene, A. F.; Sanford, J. R. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Phys. Rep.; 19: No. 4, 169-232(Jul 1975).

A survey is given of the experimental research program at the Fermi National Accelerator Laboratory covering the approved experimental proposals. These experiments are divided into physics topics, and a comparison is made of the kinematic ranges of the measurements and the techniques used. (auth)

## Auxiliaries and Components

*Refer also to abstracts 27879, 27893, 28068, 28756, 28773, 28838–28842, and 28915.*

**28801** (CONF-750941-1) POWER TRANSISTOR MODULE FOR HIGH CURRENT APPLICATIONS. Cilyo, F. F. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1975. 3p. Dep. NTIS $4.00.

From annual meeting of the IEEE Industry Applications Society; Atlanta, Georgia, USA (28 Sep 1975).

One of the parts needed for the control system of the 400-GeV accelerator at Fermilab was a power transistor with a safe operating area of 1800A at 50V, dc current gain of 100,000 and 20 kHz bandwidth. Since the commercially available discrete devices and power hybrid packages did not meet these requirements, a power transistor module was developed which performed satisfactorily. By connecting 13 power transistors in parallel, with due consideration for network and heat dissipation problems, and by driving these 13 with another power transistor, a super power transistor is made, having an equivalent current, power, and safe operating area capability of 13 transistors. For higher capabilities, additional modules can be conveniently added. (auth)

**28802** (JINR-9-8181) SOFTWARE FOR MAGNETIC MEASUREMENTS IN ADGEZATOR OF A HEAVY ION ACCELERATOR. Aleksandrov, V. S.; Barabash, L. S.; Golutvin, I. A.; Kazarinov, N. Yu.; Nevskaya, N. A.; Perel'shtein, Eh. A.; Fedunov, A. G.; Yatsunenko, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Dept. of New Acceleration Methods). 1974. 19p. (In Russian). INIS.

4 refs.; 9 figs.

Program complexes used in forming of a pulsed magnetic field in the adgezator of a multi-charged ion accelerator are described. A regime of measuring the space and time distributions of the magnetic field and its decay response are described. Program operation was studied. (tr-auth)

**28803** (LA-UR-75-1089) MONITOR: A SHORT-CUT APPROACH TO REMOTE-HANDLING AT LAMPF. Horne, R. A.; Ekberg, E. L. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 20p. (CONF-751101-11). Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The monitor, constructed from relatively cheap commercial components, is a straightforward, totally remotely operated handling system intended to work on components in the LAMPF external beam line or elsewhere. It can be towed or lifted into position, then hard-wire controlled from a distance by using television. (auth)

**28804** FIELD DISTRIBUTIONS IN A SPIRAL RESONATOR. Bendt, P. J.; Sierk, A. J.; Tombrello, T. A. (Los Alamos Scientific Lab., N. Mex. (USA)). Nucl. Instrum. Methods; 126: No. 3, 341-348(15 Jun 1975).

A simple model of the fields in a spiral resonator is presented and the predicted properties are compared with those from experiment. The model gives a very good representation of the resonant frequency of the cylindrical resonator and of the fields in all regions away from the immediate neighborhood of the midplane spiral. Shunt impedances cannot be accurately predicted because the model simplifies the form of the spiral, which affects the electrical field along the cavity axis. (auth)

**28805** PRESSURE VESSEL, ANNULAR LIFT, AND GAS HANDLING SYSTEM FOR THE 5 MV VAN DE GRAAFF GENERATOR OF ATOMKI. Koltay, E.; Morik, Gy.; Somorjai, E. (ATOMKI, Debrecen, Hungary). ATOMKI (At. Kut. Intez.). Kozl.; 17: No. 2, 131-145(1975).

Details are given of the design and working parameters of the pressure vessel, annular lift, and gas system for a 5 MV Van de Graaff accelerator. Specifications, a schematic, a diagram of the mechanical details, and an electrical schematic for the annular lift are included. (PMA)

**28806** OFFSET ELECTROSTATIC QUADRUPOLE TRIPLET CHARGE SELECTOR. Goldring, G.; Segalov, Z.; Skurnik, E. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). Nucl. Instrum. Methods; 126: No. 3, 355-360(15 Jun 1975).

An electrostatic displaced triplet for charge selection in the terminal of a 14 UD Pelletron accelerator is described. The device was checked experimentally with purely geometric displacements and with combined geometric and electric offsets. The rejection rate of charges adjacent to a selected charge is better than 1/20 for a divergent beam of 7 mrad half angle and charges as high as 14+. For a collimated beam of 1 mrad half angle, complete separation is achieved. (auth)

**28807** INTENSITY-DISTRIBUTION MONITOR FOR THE SIN EXTERNAL PROTON BEAM. Daum, M. (Schweizerisches

Inst. fuer Nuklearforschung, Villigen). Nucl. Instrum. Methods; 126: No. 4, 493-494(1 Jul 1975).

A profile monitor of the SIN extracted proton beam at the external pion-production targets was developed using a special target wheel and a beam-spill detector. (auth)

**28808** CAMAC NORMAL STATION FOR PROCESSING ION-BEAM SCANNER DATA. van Heusden, G.C.L.; Opbroek, L. R. (Technische Hogeschool Eindhoven (Netherlands)). Nucl. Instrum. Methods; 126: No. 4, 549-552(1 Jul 1975).

For automatic beam control at the Eindhoven University of Technology cyclotron, the beam width and the position in the external beam-guiding system are measured using Danfysik pin-type beam scanners. The measuring equipment is coupled with a DEC PDP-9 computer with 24k core memory via a single crate CAMAC system. The hardware processing of the beam-scanner data, using a laboratory developed CAMAC time-to-digital converter, is discussed. (auth)

**28809** COMPRESSION OF ELECTRON RING: THE SYSTEM AND RESULTS IN IPP-JAPAN. Sawasaki, S.; Kobayashi, N.; Kubota, Y.; Miyahara, A. (Nagoya Univ., Japan). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 992-994 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The compression coils are to be placed inside the metal wall of the high vacuum chamber of the ERA device at IPP-Nagoya, so that the effect of the vacuum walls must be taken into account in the coil design. The exact solutions of the magnetic field and the inductance are found, including the wall effect, using a simplified model of the wall geometry. Actual design of the compression coils and the installation of the power supply systems are also discussed. (PMA)

**28810** RESEARCH PERFORMANCES ON SUPERCONDUCTING DEVICES FOR COLLECTIVE ACCELERATOR IN JINR. Muratov, Yu. V.; Rubin, N. B.; Sarantsev, V. P.; Shishov, Yu. A.; Smirnov, Yu. I.; Zeldovich, A. G. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1003-1005(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The advantages and difficulties of using superconducting acceleration cavities for collective accelerators are discussed. The design of the KOLTSETRON cryogenic accelerator section is almost complete, and assembly tests are being made. The section, intended for proton acceleration up to 0.5 GeV, consists of four superconducting cylindrical cavities, which are placed in an axial stationary magnetic field of 2 T. (PMA)

**28811** ANALYSIS OF THE RESONANT TRANSFORMER ACCELERATOR IN THE GATED AND UNGATED BEAM MODE. Uglum, J. R. (Energy Sciences, Inc., Bedford, MA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1026-1029(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The resonant transformer accelerator has found use in both average power and pulsed power applications. An analysis is presented of some of the operational requirements, capabilities, and limitations of such systems. Many subtle engineering details (e.g., half-wavelength transformer resonances) are not considered since they do not affect the general results. Careful attention must be given to them, however, before a compact and reliable unit can be realized. (auth)

**28812** APPLICATIONS OF MICROPROCESSORS IN ACCELERATORS. Bobbitt, J. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1065-1068(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Microprocessors (mu P) are finding a growing list of applications in accelerators and associated equipment. mu P's may be used as autonomous data loggers and process controllers and in distributed systems. A mu P is essentially a computer CPU. Applying mu P centers around two distinct problems--completing the mu P into a computer and interfacing the computer to its environment. The computer can be completed with standard computer components. CAMAC was chosen to be the interface to the environment. CAMAC has several advantages at Fermilab. It is widely used, special function modules for accelerators have already been developed, and many accelerator personnel are familiar with it. Also, it is becoming more widely accepted internationally. A brief description of the CAMAC system is given. (auth)

**28813** AGS BEAM LOSS MONITORING SYSTEM. Levine, G. S.; Balsamo, J. C. Jr. (Brookhaven National Lab., Upton, NY). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1069-1071(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The usefulness of a beam loss monitoring system in diverse aspects of accelerator operation is documented with a variety of examples. (auth)

**28814** CALORIMETRIC DETERMINATION OF BEAM ENERGY. Miller, G. H.; Lockwood, G. J. (Sandia Labs., Albuquerque, NM). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1072-1075(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A high-precision calorimetric system was developed for determining beam energy. The beam is square-wave (on-off) modulated and the time derivative of the calorimeter temperature is determined at a time late in the modulation half-cycle. This avoids sensitivity variations associated with beam size and location on the calorimeter. The data are collected and analyzed in a small on-line computer. The use of beryllium, with its very small back-scatter coefficient for electrons, permits the use of the method for electron accelerators. Using such a calorimeter with a high-stability electron accelerator, standard deviations of the order of 0.03 percent for series of 20 measurements were achieved for energies from 0.025 to 1 MeV over several hours time period. The calorimeter system is usually calibrated with a low energy (approximately 20 keV) positive ion beam whose energy is well established. Where lower accuracy is acceptable, the sensitivity may be determined from first principles to within 1 percent. The method is described, and the optimization of the various parameters is discussed. (auth)

**28815** USE OF DIGITAL TECHNIQUES FOR AUTOMATIC CONTROL OF THE CS-15 COMPACT CYCLOTRON. Kuo, T. Y. T.; Shufer, M.; Conti, J.; Lee, R.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1076-1078 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A stabilization system to hold firm both rf frequency and rf dee voltage was developed, using digital techniques in the design of the control modules. Various control schemes to obtain optimum performance for this system were also developed. The external beam current was stabilized to within +-5 percent. (PMA)

**28816** COMPUTER CONTROL OF THE INDIANA CYCLOTRON. Lewis, S. A. (Indiana Univ., Bloomington). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1079-1081(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Indiana Cyclotron control system consists of several hundred cyclotron devices and two operator stations linked to a small digital computer via a bidirectional, multiplexed digital bus. All communication between operators and the cyclotron is by means of 64 displays. Provision is made for readout, control, data logging and retrieval, alarm warning, and initiation and termination of automatic control programs. Special features of the system are the modular and dynamic master table which uniformly describes the cyclotron devices to all the programs which drive them, and the dynamically reconfigurable cyclotron control displays. (auth)

**28817** CONTROL THROUGH A SYSTEM OF SMALL COMPUTERS. Mallory, K. B. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1086-1087 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The system status and executive programs are discussed for the computers used in the control of the linac at SLAC. A continuing traffic study is maintained of the flow of tasks within and between CPUs and of the use of resources such as the disk, links, interfaces, and internal I/O buffers. The study shows that the computers in the control system are idle much of the time. By controlling the peak traffic, many occasional tasks can be added as additional computer aids to the accelerator operators. (PMA)

**28818** SLAC8'S: A DISTRIBUTED ACCELERATOR CONTROL AND MONITORING SYSTEM. Struven, W. C. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1088-1090(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The latest addition to the distributed accelerator control and monitoring system achieves parallel control of multilevel functions, multisector access, as well as continuous updating of over 800 analog signals. The limitations of the preceding system are compared with the advantages of this larger network. Interface hardware and diagnostic software for the computers are also discussed. (auth)

**28819** IMPROVED DESIGN FOR THE FERMILAB SEPTA. Walton, J.; Andrews, R.; Edwards, H.; Palmer, M. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1091-1093(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Thin electrostatic septa are the most critical elements of the main ring extraction system and the beam splitting stations at Fermilab. Operating experience since the first extracted beam in 1972 has indicated several improvements needed over the original septa for both extraction (single cathode) and beam splitting (double cathode). A second generation of septa, now being implemented, is described here. (auth)

**28820** RADIATION HARDENED PROTON METER FOR FERMILAB EXTERNAL BEAM LINES. Kerns, C. R. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1104-1108(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A beam line current and charge monitor has been in use for several months with the following characteristics: (1) beam toroid in high radiation area 200 feet from electronics, and within 30 feet of the 140,000 ampere pulsed neutrino horn; (2) response time adequate to permit accurate (1 percent) measurement of 1 turn fast-extracted beam; (3) digital and analogue readouts for full scale ranges of $2 \times 10^{12}$, $1 \times 10^{13}$, and $5 \times 10^{13}$ protons per pulse; (4) computer readout and standardization via CAMAC; and (5) pulse-to-pulse repeatability is 1 in 1000 on test pulses. There is no interference from the horn, which pulses at the same time as the beam. (auth)

**28821** FULLY CAMAC INTERFACED COMPUTER CONTROL SYSTEM FOR THE VICKSI-ACCELERATORS. Busse, W.; Kluge, H. (Hahn-Meitner-Institut fur Kernforschung, Berlin). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1109-1112(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The computer control system for the VICKSI-project uses CAMAC modules as the unique interface. A single loop CAMAC-Serial-Highway will control all the equipment associated with the accelerators and the beam paths. The components of the main-control-console, as well as general maintenance-equipment, are interfaced to the computer via a Parallel-CAMAC-Highway. No further submultiplexing is done. Special attention was given to the choice and specification of CAMAC-Modules in order to reduce the number of different types and to standardize the ports to the equipment under control. The impact on hardware (cabling, maintenance, error detection) and software design is reviewed. The software itself is based on the use of a real-time executive in conjunction with an interpreter and a data base allowing a comprehensive addressing scheme and simple system tasks. (auth)

**28822** PRACTICAL CONSIDERATIONS IN THE DESIGN AND OPERATION OF SUPERCONDUCTING STRUCTURES. Schwettman, H. A. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1118-1124(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

During the past few years, considerable experience has been gained in the operation of prototype superconducting accelerators under beam line conditions. As a result of this experience, important aspects of structure design and important questions related to the long term operation of superconducting structures have been brought into sharper focus. For applications where low power loss and high duty factor, or exceptional beam quality and stable operation, are essential properties, and where modest energy gradients can be tolerated, superconducting structures are distinctly superior to conventional room temperature structures. (auth)

**28823** FERMILAB ENERGY DOUBLER, A TWO-YEAR PROGRESS REPORT. Fowler, W. B.; Drickey, D.; Reardon, P. J.; Strauss, B. P.; Sutter, D. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1125-1128(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Work was begun about 2½ years ago at Fermilab on feasibility studies for the Energy Doubler/Saver. This activity has centered on the technology of building Energy Doubler/Saver magnets and their cooling system. Energy Doubling would be accomplished by installing in the 4-mile tunnel of the Fermilab accelerator a ring of superconducting magnets. Energy Saving would use the same ring of superconducting magnets operating in a power saving mode. The motivation for the saver would be to obtain the same energy, intensity, and duty cycle of the present machine, but with a significantly reduced electrical power bill. (auth)

**28824** PERFORMANCE STUDIES OF SUPERCONDUCTING DIPOLES FOR THE FERMILAB ENERGY DOUBLER. Drickey, D.; Flora, R.; Strauss, B. P.; Sutter, D. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1137-1140(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Energy Doubler magnet development and testing program was initiated in September 1972 and has thus far proceeded through three phases. In the first phase, several wire winding geometries and the ability to reproduce magnet field properties in a pair of dipoles were explored. This phase closed with construction and operation of a 20 foot dipole magnet. When the 20 foot magnet did not perform to expectations, phase 2, a program of 2.5 foot prototype construction, was initiated. Twelve 2½ foot magnets were tested to evaluate problems of excessive training and failure to go to short sample. Sufficient information was gained about mechanical structure, wire properties and coil cooling from these studies to cause an extensive redesign of the basic Energy Doubler dipole magnet. Construction of the first magnet of new design, C1-2.5, in October of 1974 marked the initiation of phase 3 of our program. Three magnets were completed: C1-2.5, a 2½ foot magnet, went to 40 kG mounted in a horizontal cryostat with warm iron, C2-2.5 was used to explore some special concepts of coil confinement, and C2-10 was tested by a 12,000 cycle test and excitation to 25 kG without iron as a demonstration of a magnet that would allow operation of the Doubler from 100 to 500 GeV in the "Energy Saver" mode. (auth)

**28825** SUPERCONDUCTING CAVITIES FOR SYNCHROTRON USE. Kirchgessner, J.; Padamsee, H.; Phillips, H. L.; Rice, D.; Sundelin, R.; Tigner, M.; von Borstel, E. (Cornell Univ., Ithaca, NY). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1141-1143(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A 60 cm length of niobium S-band standing wave accelerator was installed in the Cornell Electron Synchrotron. During operation, the $Q_0$ remained at its initial value of $1.1 \times 10^9$, and the accelerating field at breakdown remained at 4 MeV/m. The cavity was used to accelerate the synchrotron beam to 4 GeV by itself and to accelerate the beam to 12 GeV with the normal rf system. (auth)

**28826** SUPERCONDUCTING RE-ENTRANT CAVITIES FOR HEAVY ION LINACS. Ceperley, P. H.; Ben-Zvi, I.; Glavish, H. F.; Hanna, S. S. (Stanford, Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1153-1156(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Superconducting niobium cavities of reentrant shape were built and tested at Stanford. The cavities have a 35cm diameter, 10cm length, and 2cm accelerating gap. They resonate at 430 MHz. A large number of tests show that the performance of the cavities is reproducible: field strengths in excess of 12 MV/m were consistently achieved at Q values in the range $2 \times 10^9$ to greater than $10^{10}$. The highest field obtained was 17 MV/m. To obtain these performance levels, it is necessary to use special fabrication procedures, chemical treatment, and, of perhaps greater importance, ultra high vacuum firing to temperatures of 1600 to 1800°C. The geometry of the accelerating gap of the cavities, in relation to the resonant frequency, make the cavities suitable for accelerating heavy ions with energies upward of 1 MeV/nucleon. A sequence of cavities could thus be used to boost the energy of particles obtained from existing tandem Van de Graaff accelerators. (auth)

**28827** MAGNETORESISTANCE ELEMENTS FOR THE MEASUREMENT AND CONTROL OF HARMONICS IN SUPERCONDUCTING ACCELERATOR MAGNETS. Sampson, W. B.; Robins, K. E.; Thomas, M. G. (Brookhaven National Lab., Upton, NY). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1157-1159(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A system for continuously monitoring the harmonic coefficients of a superconducting accelerator is described. The method employs a series of magnetoresistance elements placed at specific locations around the circumference of the usable aperture. Difference signals from these probes are used to determine the harmonic coefficients. This method does not require integration of the field measuring signals or rotation of the probes, so the elements can be built into the magnet during construction. Experimental results are given for the simplest configuration and these results are compared to the sextupole signal measured in a more conventional way. (auth)

**28828** ELECTRICAL PROTECTION OF SUPERCONDUCTING MAGNET SYSTEMS. Sutter, D. F.; Flora, R. H. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1160-1163 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The problem of dissipating the energy stored in the field of a superconducting magnet when a quench occurs has received considerable study. However, when the magnet becomes a system 4 miles in length whose normal operation is an ac mode, some reexamination of standard techniques for dissipating energy outside the magnets is in order. Data accumulated in the Fermilab Energy Doubler magnet development program shows that heating associated with the temporal and spatial development of quenches is highly localized and can result in temperatures damaging to the superconducting wire. The design and operation are discussed for several energy dumping schemes, compatible with the operation of ac superconducting magnets, wherein more than 70 percent of the stored energy can be dissipated outside the magnet. Instrumentation to detect quenches early in their development and circuits for dumping the field energy are described, and representative operating performance data for the dump circuits and data showing temporal development of quenches are presented. (auth)

**28829** ESCAR HELIUM REFRIGERATION SYSTEM. Byrns, R.; Green, M. A. (Univ. of California, Berkeley). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1168-1171 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The ESCAR cryogenic system, with its two distribution loops, offers many advantages. The system models the kind of system that can and should be used in future accelerators. The refrigerator cold box, with its turbine expanders, and the helium screw compressor system represent a significant step in the development of reliable helium refrigeration systems. (auth)

**28830** INVESTIGATIONS OF SUPERCONDUCTING HELIX RESONATORS FOR A HEAVY ION POST ACCELERATOR. Piosczyk, B. (Kernforschungszentrum, Karlsruhe, Ger.); Hochschild, G.; Vetter, J. E.; Jaeschke, E.; Repnow, R.; Walcher, T. IEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1172-1175 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

As a part of a feasibility study, the design and the construction of an accelerator section to be tested at the heavy ion beam of an electrostatic tandem Van de Graaff was begun. This test section consists of a cryostat with two independently phased lambda/2-helix structures at 108 MHz and of a suitable rf-control system. Design criteria and recent results of measurements on a superconducting test cavity with electric surface peak fields up to 29 MV/m are presented. (auth)

**28831** NEW SUPERCONDUCTING HEAVY ION ACCELERATING STRUCTURE USING CHEMICALLY POLISHED LEAD SURFACES. Shepard, K. W.; Mercereau, J. E.; Dick, G. J. (California Inst. of Tech., Pasadena). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1179-1182 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A new heavy ion accelerating structure was developed which, together with a parallel development in chemical polishing techniques, makes possible very high accelerating fields for a wide range of particle velocities using inexpensive and easily handled materials. This "Split Ring" accelerating structure has a peak magnetic field approximately one third that of other inductively loaded accelerating structures (less than 100G at 1MV/m accelerating field) and a peak electric field less than 6 times the effective accelerating field. In addition, a chemical p 'ishing technique appropriate for use on electroplated lead surfaces was developed which greatly reduces the electric field emission of electrons from the surface. Surface fields greater than 25MV/m were obtained in superconducting resonators with polished lead surfaces with no detectable loss due to field emission. An accelerating field greater than 4 MV/m in a superconducting structure was achieved, and long term tests were begun. Preliminary results indicate no surface degradation at high fields (greater than 3MV/m) for relatively long times (14 hours). (auth)

**28832** THERMAL CONDUCTANCE MEASUREMENTS OF MECHANICAL SUPPORTS FOR SUPERCONDUCTING MAGNETS. Kuchnir, M.; Sanger, P. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.). Trans. Nucl. Sci.; NS-22: No. 3, 1183-1184 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The space confinement and warm iron shielding envisioned for the superconducting magnets of the Fermilab Energy Doubler impose high demands on the insulating support system with regard to stiffness and thermal conductance. In order to adjust the minimum heat load to a reasonable refrigeration power, a study of the heat conduction through the support was undertaken. The use of multilayer insulation can reduce the infrared radiation load to a small fraction of the conduction load. A study was made of the design of several possible supports, steady-state thermal analysis calculation for two supports, and the development and use of a new method for measuring their thermal conductances. The thermal conductance measurements are discussed in detail. (auth)

**28833** OPERATION OF SUPERCONDUCTING MAGNETS IN FERMILAB EXTRACTED BEAMS. Rode, C.; Gavin, P.; Norton, R. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1185-1187 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The design and layout of the refrigeration, transfer, and magnet systems are discussed. Data on heat leaks and beam losses are presented (auth)

**28834** TESTS ON S-BAND SUPERCONDUCTING NIOBIUM PROTOTYPE ACCELERATOR STRUCTURES. Kneisel, P.; Lyneis, C.; Turneaure, J. P. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1197-1200 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The fabrication, processing, and measurement of two S-band niobium prototype electron accelerator structures are discussed. Maximum surface magnetic fields were typically between 250 and 350 Oe, corresponding to average energy gradients between 4.6 and 6.5 MeV/m, with $Q_0$ values typically greater than $3 \times 10^9$. The structures which were electropolished gave more reproducible results than those which were chemically polished. (auth)

**28835** FERMILAB ENERGY DOUBLER MAGNETS: MAGNETOSTATICS. Snowdon, S. C. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1206-1210 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Magnetic field computations were performed for the three-inch circular aperture doubler magnets in the warm iron geometry. Locations for rectangular conductors along circular arcs were found such that, in the absence of the construction errors, the sextupole and decapole terms have been removed from the dipole. For the quadrupole, suitable locations for the conductors were found that remove the duodecapole term. Field quality, longitudinally integrated fields, construction errors, forces, energy content, and eddy current heating under cycled conditions are discussed for a 45 kG dipole and a 20 kG/inch quadrupole. (auth)

**28836** DESIGN AND PERFORMANCE ASPECTS OF A PRECISION HIGH-CURRENT POWER SUPPLY. Cilyo, F. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1238-1241 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Ferrite Bias Supply, in essence, is an error power amplifier in the resonant cavity frequency tuning system. As such, it accepts inputs from a programmed voltage source and from a phase detector. In response to these input signals, it produces dc current in the tuner windings as required for resonant frequency. The resulting amper-turns saturate ferrite cores, changing the inductance and the resonant frequency of the cavity. Because of its strategic location, the performance and operational requirements on the bias supply are severe. There are 16 bias supplies in the booster and 16 in the main accelerator, with additional units to be added. (auth)

**28837** MULTIPLE FLATTOP CONTROL SYSTEM FOR THE FERMILAB MAIN ACCELERATOR POWER SUPPLIES. Cassel,

R. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1247-1248 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Fermilab Main Accelerator was originally designed to operate with a bending magnet guide field consisting of an injection period, a linear acceleration period, a single extraction period called a "flat-top" and an "invert" or recovery period. The same cycle would then be repeated at a fixed repetition rate. The main power supply system was designed and has been operating under those constraints for several years. With the advent of additional beam lines and numerous experiments, the single extraction energy and repetition cycle has become restrictive and wasteful of energy and accelerator operating time. The nonregulated recovery period has resulted in difficulties with injection remnant fields. The existing hardware consisting of individual waveform generators for each power supply was not sufficiently flexible to allow for variations in the number of flattop periods per cycle or variations cycle to cycle. A new program to control the main accelerator power supplies was undertaken to provide sufficient flexibility to generate multiple "flattops" and multiple cycles with detailed shaping and regulation of the recovery period. A further goal of the new program was to make generation of a new program simple and fast. (auth)

**28838** RADIO FREQUENCY SYSTEM FOR THE INDIANA UNIVERSITY ISOCHRONOUS SEPARATED SECTOR CYCLOTRON. Hoffert, W. J. (Indiana Univ., Bloomington); Donica, G.; Varga, H. J.; Herman, H. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1265-1268(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Indiana University Cyclotron design includes seven resonators excited at radio frequencies between 25 Mhz and 36 Mhz. Three of these resonators are associated with the chopper, buncher, and pulse selector. Two are in the injector accelerator and two in the main accelerator. A common reference frequency drives independent amplifier chains for each resonator. All systems may be adjusted for any phase relationship and power level up to design maximums. Once established, phase and power levels are maintained by closed loop control circuits. An auto-tune feature is incorporated in the control circuits to keep resonators at exact resonance and to automatically retune when the operating frequency is changed. Multipactoring break-through is enhanced by pulsing the amplifier drive and by over-coupling amplifiers to the resonators until normal field is attained. (auth)

**28839** DESIGN AND OPERATION OF THE SPEAK II RF SYSTEM. Allen, M. A.; Ecken, R. A.; Genova, L.; Humphrey, B. E.; Karvonen, L. G.; Konrad, G. T.; Lebacqz, J. V.; McConnel, R. A.; Olson, C. W. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1269-1272(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The SPEAR storage ring was initially designed to operate at an energy of 2.5 GeV but with a capability built into the magnets for operation above 4.0 GeV. To operate at these high energies, a completely new rf system was necessary. Four straight sections were available to provide the over 7 megavolts of rf necessary. A frequency of 358 MHz was chosen, and a decision was made to use klystron amplifiers for the power tubes. (auth)

**28840** DC CHOPPER USED AS AN ADJUSTABLE CURRENT BYPASS SHUNT. Berndt, M.; Guracar, C.; Lipari, J. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1273-1276(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In a synchrotron machine of the separated function magnet type, if the quadrupole magnets can be made to change exactly together with the bending magnets, the result will be no shift in the betatron tunes, but only a shift in energy. In the SPEAR ring this feature is used to advantage. Selected groups of quadrupoles that have a particularly pronounced effect on the machine tunes were designed to operate at a current slightly less than the bending magnet current. These quadrupoles are then energized in series with the bending magnets, except for an adjustable current bypass shunt, capable of diverting up to 20 percent of the total current. (auth)

**28841** TRANSDUCTORS FOR CURRENT SENSING IN THE DIPOLE AND QUADRUPOLE MAGNET CIRCUITS OF THE FERMILAB MAIN RING. Kerns, Q. A. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1277-1280(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Transductors are used as current measuring devices in the main accelerator quadrupole power supply feedback loop and as monitors in the dipole circuit. The development of these transductors is described, starting with the basic series-connected (Kraemer) transductor circuit, and adding the features of biasing and a voltage follower to obtain improved linearity and high slewing rate. (auth)

**28842** OFF-LINE INVERTER MAGNET POWER SUPPLY. Grazier, R.; Main, R. M.; Spence, D. A. (Ceronics Inc., Berkeley, CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1281-1284(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A high current, intermediate power, off-line inverter power supply was developed for use with high inductance magnet loads. Two banks of paralleled switching transistors directly invert the rectified line at 5-10 kHz into the power transformer primary. Paralleled center-tapped secondaries are full-wave rectified directly into the inductive load. The primary switches are pulse-width modulated to provide the full range of output current. Regulation is $1:10^4$, with long-term stability about $2:10^4$. The control circuitry is highly noise immune. Protection for the semiconductors is provided by an over-current sensor which terminates the drive signal to the switches quickly enough to protect against all faults, including output short-circuits. The magnet is protected against over-voltage by the inherent free-wheeling operation of the secondary diodes. Electrical efficiency is greater than 80 percent over the entire current range, and the supply is extremely small and lightweight. A triple unit, consisting of three water cooled 2.5 kVA supplies, measures 5 x 7 x 17 inches and weighs 30 lb. Other units have been built with power to 4.5 kVA at 150 amperes. (auth)

**28843** DIELECTRIC PROPERTY MEASUREMENTS ON LARGE ALUMINA VACUUM SEALS USED ON FERMILAB ACCELERATOR RF CAVITIES. Bridges, J. F.; Johnson, D. E.; Griffin, J. E. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1296-1297(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The rf window vacuum seals on the 400-GeV Fermilab accelerating rf cavities are very large circular cylinders of alumina. The cavities were first installed with seals of 94 percent purity $Al_2O_3$. Several of these seals failed in high-power operation due to dielectric heating. Higher purity ceramics (99.5 percent $Al_2O_3$) were obtained and are now being installed. The complex permittivity of both types of ceramic was measured in a $TM_{010}$ mode test cavity ten inches high and eight feet in diameter. Frequency shift and Q shift data were analyzed by perturbation analysis and by computer programs. Results confirm that the higher purity ceramics have a loss tangent a factor of five better than the original seals. Some high-power operational test results are also presented. (auth)

**28844** POWER SUPPLY SYSTEM FOR BEAM STEERING. Gano, J. J. (Massachusetts Inst. of Tech., Middleton). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1311-1312(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The power supply system for steering the Bates Linac beam provides continuous adjustment of the current from +2.5A to −2.5A per pair of coils at +−25 volts. A simple, inexpensive system has been assembled from off-shelf components. Separate controls for 26 pairs of coils are provided by means of power operational amplifiers and drivers connected in series with the coils across a common pair of +−30 V busses. No current regulation is used. After coils and amplifiers have reached thermal equilibrium (about one-half hour at 2.5A) the current is stable within 0.5 percent. (auth)

**28845** 230 kJ PULSED POWER SUPPLY. Winje, R. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1317-1320(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Meson Focussing System (Horn), consisting of two single-turn coaxial structures, in which circular magnetic fields of varying intensity are produced, and a 230 kJ pulsed power supply, was built and operated at Fermilab. The development and construction of the power supply and its related control system are reported. The capacitor discharge series resonant network was chosen because of the ability to generate the required high current

at a relatively modest voltage. Ignitrons are used as the switching elements. A dual set of ignitrons and their controls are connected to the capacitor bank which allows the time-shared operation of the power supply into two loads without the necessity of mechanical, high-current switching. The alternate load for the power supply is a test area where development work on new horn system components is carried out. (auth)

**28846** STATUS REPORT ON KLYSTRON IMPROVEMENTS. Lebacqz, J. V. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1324-1327(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A program of improvements of the high power pulsed klystrons used in the gallery at SLAC, originally designed to operate at 250 kV with a peak power output of between 21 and 24 MW is reported. The design of a new high efficiency klystron is reviewed, including special requirements for electromagnets and interlocks for focusing the tubes, as well as the performance of the first two sectors. The operating life experience of all high power pulsed klystrons used at Stanford is discussed. (auth)

**28847** 20 MeV S-BAND STANDING WAVEGUIDE. Whitham, K. (Applied Radiation Corp., Walnut Creek, CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1328-1333(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A description of the design and performance of a 20 MeV, side-coupled, S-Band Standing Waveguide for electron acceleration is given. Performance data pertinent to the application of this accelerator to cancer therapy is given and discussed. (auth)

**28848** EVOLUTION OF THE rf SYSTEM OF THE CPS BOOSTER SINCE THE BEGINNING OF ITS OPERATION. Gelato, G.; Magnani, L.; Nassibian, G.; Pedersen, F.; Zanaschi, D. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1334-1336(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Since the first beams were accelerated in 1972, the rf system has performed very satisfactorily. In particular, the simple air-cooled design of the cavity and final amplifier has proved to be very trouble free in operation. As the beam intensities gradually reached and then exceeded the design value of $2.5 \times 10^{12}$ protons per ring, a number of improvements were introduced to cope with the increased beam loading and to permit the special beam gymnastics that have been found useful at the highest intensities. Modifications include: (1) provision for reducing the Q of the cavity during trapping; (2) an improved system for synchronizing the four rings prior to ejection; (3) measures taken to control longitudinal instabilities; and (4) safety precautions to protect the cavity and amplifier against transients. (auth)

**28849** PHASE-FREE ACCELERATION OF CHARGED PARTICLES USING RECTANGULAR DRIFT TUBE-LOADED CAVITIES. Schott, W.; Zinner, H.; Wilhelm, W.; Hagn, H.; Daniel, H. (Univ., Munich). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1337-1340(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Rectangular drift tube-loaded cavity resonators, operated in the TE 101 mode, were tested for their use in a phase-free accelerator. Perturbing object measurements combined with numerical calculations show that the energy gain depends strongly on the shape of the drift tubes and on the position of the beams in the reference plane. Particles are accelerated in one direction within a range of about 10 cm using 25 cm wide drift tubes with straight and pointed shapes, respectively. The energy gain of one cavity was measured directly at magnetic field of 1.6 G and an electron beam of 20 keV. The time averaged energy gain of 15 eV is in good agreement with the theory. An example of an accelerating device which might be used to produce a large circulating current of electrons of 50 MeV is sketched. The cavities are placed within the gaps of spiral ridge magnets. (auth)

**28850** INTERACTION OF ACCELERATOR CONTROLS AND DIAGNOSTICS. Shea, M. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1458-1465(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Computer control systems have been in use on operating accelerators for several years. A discussion and some examples are given of ways in which control-system equipment can be used by accelerator engineers and physicists to study beam properties and operating characteristics of accelerator components. (auth)

**28851** FERMILAB TRANSVERSE INSTABILITY ACTIVE DAMPING SYSTEM. Higgins, E.; Kerns, Q.; Miller, H.; Prichard, B. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1473-1474(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A system for controlling vertical single bunch instability is described. The vertical position of each of the 1113 bunches in the Fermilab Main Ring is digitized and stored in a memory. After an interval determined by counting rf cycles, the memory is read. The delayed position signal is sent to a distributed amplifier. A transmission line serves as a beam deflector. (auth)

**28852** SODIUM CURTAIN BEAM PROFILE MONITOR OF THE ISR. Vosicki, B.; Zankel, K. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1475-1478 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The instrument displays the cross-section image of the ISR proton beam on a television screen. Beam density distributions across the horizontal or the vertical axis, as well as their simultaneous perspective display (i.e., mountain range), are displayed on an oscilloscope. The monitor does not impair the ultra-high vacuum of the ISR, nor does it destroy or degrade the proton beam. The beam image is formed by extraction and acceleration of electrons, produced by the beam in a thin curtain-shaped sodium vapour jet, on to a fluorescent screen. The curtain is inclined at $45^0$ to the vertical in order to obtain the horizontal and the vertical profile simultaneously. The geometrical definition of this apparatus is better than 1 mm. (auth)

**28853** FERMILAB NEUTRINO: HORN FOCUSSING SYSTEM. Nezrick, F. A. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1479-1483(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

To increase the flux of neutrinos at the Fermilab accelerator over the entire neutrino energy spectrum, a high efficiency horn-focussed beam was developed. The horn system is well known for its high acceptance and highly achromatic focussing of charged particles formed at the production target into a low divergence beam. This meson beam is allowed to decay in a 400 m long vacuum region producing neutrinos and muons. The muons are absorbed from the beam by using 1 Km of earth, allowing the filtered neutrino beam to pass through the experimental detectors. The equipment and results of the focussing region are discussed. (auth)

**28854** IUCF PHASE PROBE. Kowalski, E. A.; Devins, D. W.; Seidman, A. (Indiana Univ., Bloomington). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1505-1508(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A non-intercepting, charge-sensitive, sampling beam probe was developed for use in internal beam phase measurements in the variable-energy, separated sector injector cyclotron at Indiana University. The two probe pickup plates of 10 mm by 16 mm are located above and below the median plane, with sampling diodes in close proximity. The probe head is mounted on a movable assembly, permitting continuous observation of phase history from inflection radius through extraction radius, at interval beam currents of 100 nanoamperes or greater with pulse rise times of less than one nanosecond. Over a two-year period the phase probe proved relatively reliable and easy to use for confirming trim coil adjustments and orbit dynamical isochronization procedures. The probe display, in addition to providing data on phase group width and centroid versus radius, on occasion shows up ion source ripple and radio frequency parasitic generation which might otherwise be overlooked. (auth)

**28855** VARIABLE-LENGTH TIME DELAY FOR 50 MHz SAMPLED ANALOG SIGNALS. Biwer, R.; Tool, G. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1509-1512 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A Super Beam Damper which makes independent corrections to each of the 1113 beam bunches in the Fermilab Main Accelerator was built to damp vertical instabilities at high intensity. As the 53 MHz beam bunches pass a point in the accelerator, a position measurement made for each bunch is delayed for one turn around the accelerator (21 musec) and is then applied to a correction device when that bunch arrives. This process occurs continuously

for each bunch. The 1-turn signal delay hardware is described. (auth)

**28856** BEAM POSITION MEASUREMENT SYSTEM AT THE FERMILAB MAIN ACCELERATOR. Kerns, Q. A. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1513-1516(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The beam position system of the Fermilab Main Ring contains one horizontal and one vertical Electrostatic Beam Pickup in each of the 96 cells of the machine. A pair of 75 ohm cables transmits the induced signal from the machine tunnel to the nearest service building. In each of the 24 service buildings, there is a solid-state multiplexer and a beam position detector which processes the A-B signal pairs to produce an intensity-normalized voltage proportional to beam displacement. This voltage is digitized, read into buffer of the Lockheed MAC A, and in turn transferred to the Xerox 530. Horizontal or vertical orbits can be obtained in 50 millisec. Orbits are obtained at injection and at a Main Ring Sample time, if requested, anywhere on the acceleration cycle. Injection orbits can be flattened automatically by a program that sets dipole trim magnets. (auth)

**28857** CALIBRATION OF THE BEAM-SPILL CONTROL SYSTEM AT LAMPF. Parker, J. R.; Liska, D. J. (Los Alamos Scientific Lab., NM). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1517-1521(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A technique is described for in-situ calibration of the beam-spill control system at LAMPF. Radiation produced by intercepted beam at the wire scanners is employed as a test source. It is shown that the secondary emission current from the wire scanner is a useful measure of the intercepted beam. The wire scanners are inserted into the beam by a digital-data servo system until the desired level of radiation is produced. Interesting digital-data servo-loop responses are displayed. The entire calibration procedure is programmed by the accelerator control computer and can be repeated as often as required without turning off the beam. The calibration programs have been written so that the conditions of the detectors and signal cables are determined and recorded. (auth)

**28858** NEW PULSE MAGNET DESIGN UTILIZING TAPE WOUND CORES. Brunk, W. O.; Walz, D. R. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1548-1551(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Pulse magnets were built using tape wound cores in order to lower magnet power requirements at high pulse repetition rates and at high gap flux densities. The primary reason this project was undertaken was to bend higher energy beams with existing power supplies. A decrease in the amount of electrical steel from 2720 kg for the original laminated core pulse magnet design to 260 kg and the elimination of the ceramic vacuum chamber resulted in substantial savings. Two new magnets are now operational with the capability of deflecting 40 to 50 GeV/c beams through $\leftarrow 0.35^0$ (6.13 mrad) at a PRR equals 360 pps. The old magnets with the same power supplies could only bend 21 GeV/c beams through the same angle. Principal features of this design, including test data, are presented. (auth)

**28859** THIN FILMS ON LINAC BEAMS AS NON-DESTRUCTIVE DEVICES FOR PARTICLE BEAM INTENSITY, PROFILE, CENTERING, AND ENERGY MONITORS. Wartski, L. (CNRS, Orsay, France); Roland, S.; Lasalle, J.; Bolore, M.; Filippi, G. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1552-1557(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The optical transition radiation emitted by electron-irradiated aluminum, silver, gold-coated plates, and self-supported metallic and mylar films was investigated experimentally using $45^0$ incident electron beams with intensities from 100 pA to 10 muA, and energies from 35 to 72 MeV. Beam diagnostics (intensity, profile, centering, energy) were made using an appropriate optical arrangement, together with a two-parallel foils device in which the interference phenomena in transition radiation emitted at both interfaces was exploited. The intensity of light integrated in a small aperture at the center of the interference pattern presents a strong particle-energy dependence (of the form approximately $E^8$), which was used in the optimization of the phase adjustment of the electron bunches in the linac at small current intensities. Moreover, study of the visibility of fringes yields an estimate of the transverse momentum spread of the electron beam and the r.m.s. angle of multiple scattering in a given material. (auth)

**28860** HIGH RESOLUTION BEAM PROFILE MEASUREMENTS USING PHOSPHORESCENCE. Bjarngard, B. E.; Chen, G. T. Y.; Maddox, B. J. (Harvard Medical School, Boston). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1558-1560 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Commercially available thermoluminescent material, $CaSO_4$:Mn incorporated in Teflon tape, is used in a phosphorescent decay mode to measure beam profiles. The light image resulting from radiation exposure is scanned by a microscope-photomultiplier system having a spatial resolution of 0.25 mm. Several applications to various types of accelerator beams are presented. (auth)

**28861** WIDE BAND FERRITE BEAM CURRENT MONITORS. Broberg, J. B. (National Bureau of Standards, Washington, DC). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1565-1566(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A ferrite electron beam current monitor was developed for use with the NBS Linac. This monitor is useful at the fast rise times (less than 5 ns) needed for the short pulsing of the linac, and also gives good flat top response for the long pulse (up to 5 mus) work. The low frequency response is achieved by using ferrite with a large mu (equals 5000) and a large number of turns (100). At the higher frequencies, the core plays a very small role and the structure acts as an air core transformer. The main difficulty observed with other types of ferrite transformer monitors has been ringing due to coil resonances, making these transformers unsuitable for use with fast rise times. This ringing was eliminated by placing damping resistors around the coil and tying them to a common but independent annular ring adjacent to the coil. (auth)

**28862** FAST DIGITIZER AND DISPLAY SYSTEM. Tool, G. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1567-1569(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Turn-by-turn information about beam characteristics in an accelerator is a valuable diagnostic aid to accelerator study and development. A fast Digitizer and Display System was built which takes up to four simultaneous "snapshots" of beam or related parameters during 256 consecutive passes at one or more detection points in the accelerator. The four digitizers may be separated by hundreds of feet so they can be located near the signal source. Each digitizer is connected to a central receiver unit by a single coaxial cable, so distance is limited only by attenuation in this cable. The system is used for Fermilab Main Accelerator development and injection tuning in which the measurement period is 21 musec. It is capable of digitizing every 1.5 musec for use on sequential turns of the Fermilab Booster Accelerator. (auth)

**28863** HIGH-SPEED BEAM POSITION ELECTRONICS FOR ACCELERATOR CONTROL AND DIAGNOSTICS. Higgins, E. F.; Griffin, J. E. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1574-1577(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Fast beam position electronic processing devices are an integral part of the on-line and diagnostic components for the Fermilab accelerator. Devices were developed which do not depend on repetitive beam signals for their operation, so that they are useful for analysis of both circulating beams and single beam passage (as in beam injection, transfer, or extraction). A capsule description is given of each type of position device, together with their relevant parameters. (PMA)

**28864** 53 MHz RANDOMLY TRIGGERED SYNCHRONOUS PREDETERMINED SCALER FOR ACCELERATOR DIAGNOSTICS. Higgins, E. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1578-1580(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A 53 MHz random triggered recycling, predetermined start-stop scaler is described. The scaler has a range from 2-to-9999 counts, sensitivity of 40 mV rms, and provides both NIM and TTL standard logic outputs. The scaler is composed mainly of standard ECL integrated circuits including universal counters, configured in a "synchronous parallel carry" connection, and ordinary logic gates and flip-flops. Special circuitry was designed to prevent start-up counting errors due to the phase randomness between the applied start triggering and input signal transitions. Following a

start trigger, the scaler cycles until disabled, delivering an output pulse each time the predetermined count is reached. The time jitter of the output pulses with respect to the periodic input signal is less than 0.1 ns. High resolution examination of the behavior of individual charge bunches within the accelerator is made possible when the scaler is set one digit away from the harmonic number, the output pulses advance one bunch for each turn around the machine, allowing a sequential display of the contents of each bucket in the machine. (auth)

**28865** BEAM SIGNAL PROCESSING FOR THE FERMILAB LONGITUDINAL AND TRANSVERSE BEAM DAMPING SYSTEMS. Higgins, E. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1581-1585(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A beam signal processor is used to secure the position of each charged bunch in the Fermilab main synchrotron. The signal processor operates at 317 MHz, 6 times the fundamental beam component and uses an amplitude-to-phase converter/hard limiter combination to obtain a normalized position signal. The normalization process is complete in less than 10 ns and is effective over a 23 dB intensity range. The methods used to sample and process the 2 ns beam signal are discussed, and the principal parameters of the device are listed. The processor outputs the derived position data to elements in a closed-loop beam damping system. (auth)

**28866** NINA PROGRAMMED QUADRUPOLES. Marks, N.; Lyall, J. B.; Poole, M. W. (Daresbury Lab., Warrington, Eng.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1586-1588(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In order to improve the high energy focussing and to provide for separated function extraction, four pairs of quadrupole magnets were recently added to the lattice of the 5 GeV fast cycling electron synchrotron NINA. Because of the complexity of the system, computer control of the pulsed waveform is required, and the programmed power supplies can track widely varying waveform shapes. The system is now commissioned and operating. (auth)

**28867** LLL 100-MeV ELECTRON LINAC: DESIGN CONSIDERATIONS AND PERFORMANCE OF THE BEAM-TRANSPORT VACUUM SYSTEM. Lara, M. C.; Brooks, H. E. (Univ. of California, Livermore). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1609-1612(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The vacuum system is described for the beam-transport lines used with the Lawrence Livermore Laboratory 100-MeV electron-positron linear accelerator. It is operated in the high ($10^{-4}$ to $10^{-5}$ Pa) range using standard ion pumps with turbomolecular pumps for roughdown. The important factors considered during the initial design phases are reviewed; these factors contributed to the very reliable performance of the vacuum system since its startup five years ago. The cleaning and handling procedures used on the beam-transport lines, magnet vacuum chambers, and other vacuum components are discussed. (auth)

**28868** ABSOLUTE CHARGE STATE YIELDS OF 20 MeV I IONS SCATTERED FROM ARGON AND XENON. Alton, G. D.; Biggerstaff, J. A.; Bridwell, L.; Jones, C. M.; Kessel, Q.; Miller, P. D.; Moak, C. D.; Wehring, B. (Oak Ridge National Lab., TN). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1685-1689(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Absolute yields of charge states resulting from the scattering of 20 MeV Fe and I ions were determined for scattering angles from $0^0$ to $1.5^0$. Measurements were made over the pressure range of $10^{-3}$ to 1 Torr, as measured in a 2 cm long differentially pumped cell, corresponding to the transition region for nonequilibrium to equilibrium final charge state distributions. The final charge state yields were found to be independent of the initial charge state of the ion species. The relatively large integrated yields make the technique attractive for possible use as a terminal stripper in large tandem accelerators. (auth)

**28869** IMPROVED VAN DE GRAAFF BELT CHARGE REGULATOR. Ziegler, N. (Oak Ridge National Lab., TN). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1730-1731 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

New belt charge regulators were installed on the CN and EN Van de Graaff accelerators at ORNL, allowing considerably more flexible control of the belt charging current than did the original circuits. Aside from the series regulator tube, all components are now solid state. Control of the series regulator (at high voltage) is achieved through optical coupling. (auth)

**28870** COMPENSATION FOR BEAM LOADING IN THE 400-GeV FERMILAB MAIN ACCELERATOR. Griffin, J. E. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1910-1913 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

At the design ramp slope of 125 GeV per second and $5 \times 10^{13}$ protons per pulse, the rf system in the Fermilab main accelerator must deliver 1 megawatt of power to the proton beam. Rf amplitude and phase changes resulting from beam loading during acceleration are compensated for by separate but somewhat slow feedback systems. Phase shifts resulting from transient beam loading during injection are compensated for by a third feedback system of broader bandwidth. The feedback systems are described, and performance details are discussed. (auth)

**28871** STATUS OF CORRECTION MAGNET SYSTEMS IN THE MAIN RING AT FERMILAB. Stiening, R.; Prichard, B. A. Jr.; Ohnuma, S. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.). Trans. Nucl. Sci.; NS-22: No. 3, 1934-1937(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

For reducing the chromaticity and suppressing various resonances, several systems composed of trim quadrupoles, skew quadrupoles, regular and skew sextupoles, and octupoles are now used in the main ring. These systems make it possible to achieve the transmission in the main ring of 90 percent or better for routine operation with the intensity in excess of $10^{13}$ protons per pulse. In particular, insertion of one-inch plastic spacers in chromaticity correcting sextupoles was very effective in compensating for high-order nonlinear fields in the bending magnets. (auth)

**28872** A HIGH-PRECISION FERRITE-INDUCTION BEAM-CURRENT MONITORING SYSTEM. Steiner, R.; Merle, K.; Andersen, H. G. (Mainz Univ. (F. R. Germany). Inst. fuer Kernphysik). Nucl. Instrum. Methods; 127: No. 1, 11-15(15 Jul 1975).

The construction and performance of a Ferrite-induction current monitoring system for charged-particle beams with pulse lengths less than 3 $\mu$s and pulse repetition rates up to 1 kHz are described. An absolute accuracy of better than 0.2% was achieved for average currents between 0.01 and 30 $\mu$A and a pulse repetition rate of 100 Hz. Particular emphasis is placed on a detailed analysis of the design parameters, which limit the ultimate accuracy of the current monitoring system. (auth)

## Ion Sources and Injection and Extraction Systems

*Refer also to abstracts 28760 and 28785.*

**28873** INJECTION AND ACCELERATION OF PROTONS IN THE ZERO GRADIENT SYNCHROTRON (ZGS) BY STRIPPING H IONS. Crosbie, E.; Gorka, A.; Parker, E.; Potts, C.; Ratner, L. (Argonne National Lab., IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1056-1059(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The booster injector program for the ZGS requires the stripping of $H^-$ ions at 50 MeV as the source of protons in the booster accelerator. Using the former Cornell 2.2 GeV electron synchrotron as a prototype booster, the injection of protons by stripping negative hydrogen ions in a poly-paraxylene thin film has already been demonstrated at the ZGS. A brightness multiplication factor of 100 was achieved, the limiting factor being the scattering of the circulating protons in the stripping foil. Until now the booster injection and operation studies were limited to ZGS off periods, because the 50 MeV $H^-$ ions are obtained by the same accelerating system that produces the 50 MeV protons required for injection into the ZGS. With the planned installation of Booster-II, it will be desirable to use $H^-$ ion stripping injection into the ZGS, so that the booster tune up studies can be carried on during normal ZGS operation. Two ZGS $H^-$ injection trials were performed during the past year, and $H^-$ stripping injection into the ZGS was found to be feasible. Only a small improvement in $H^-$ current is required to make the process competitive with regular proton injection. (auth)

**28874** INFLECTION AND EXTRACTION SYSTEMS AT THE INDIANA UNIVERSITY CYCLOTRON FACILITY. Pollock, R. E.; Dreisbach, J.; Hicks, J.; Lewis, S.; Friesel, D.; Smith, W.; Schwandt, P.; Madland, D. (Indiana Univ. Cyclotron Facility, Bloomington). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1094-1096(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Properties of the magnetic and electrostatic elements which inflect beams into the extract from the injector and main stage cyclotrons at IUCF are described. Orbit separation is such that the assistance of orbit dynamical resonances is not employed. The beam stays in the median plane in all four systems. Inflection occurs after the beam has entered the cyclotron through one of the nearly field-free valleys; the beam crosses the central region and then experiences a bend of nearly $90^0$ to enter the proper accelerated orbit. Extraction is accomplished by placing a substantial (approximately $45^0$) bending magnet in one of the valleys just outside the region of circulating beam. Smaller elements upstream are then used to deflect the last turn so that it enters this magnet. (auth)

**28875** PRECISION CURRENT TRANSDUCTOR FOR THE FERMILAB BOOSTER MAGNET POWER SUPPLY. Dinkel, J. A.; Donaldson, A. R. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1234-1237(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Fermilab Booster synchrotron requires precise injection and extraction field regulation (+- 0.001 percent repeatability). To achieve this tolerance with a current regulator requires that the current measuring device have a high degree of resolution, stability, and a high output level. To meet this criteria, a transductor using the second-harmonic magnetic modulator technique was chosen. This device is capable of better than +- 0.001 percent measurements from dc to 15 Hz for currents from 50 to 1200 A. Small signal (approximately 100 A peak-to-peak) response is 3 db down at 10 kHz. The conversion gain was chosen as 1 V/121.25 A to permit operational amplifier compatible signal levels at the output. (auth)

**28876** 110 kA RAPID-PULSING POWER SUPPLY. Winje, R.; Bourkland, K. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1242-1246(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The multi-turn injection of 200-MeV protons into the Fermilab 8-GeV Booster Synchrotron requires the shifting of the closed orbit towards the inflector septum. This local orbit bump is produced by a symmetrical arrangement of two double-bend magnets; one increasing the radius of the beam, the second decreasing the radius. The load for the power supply consists of these two identical magnets, one located at the upstream end of the booster injection girder, and the other at the downstream end of the injection girder. Each magnet assembly consists of two magnets connected in parallel in such a manner as to provide equal but opposite magnetic fields. The amplitude of the closed orbit shift is required to decrease as each successive turn is injected. For optimum efficiency, the rate of decay of the magnetic field should be linear. A good approximation can be achieved from a sine curve in the region from 5/6 pi to pi. The power supply which is used to furnish excitation currents to the orbit bump magnets is designed as a series resonant, capacitive discharge system with thyristor switches. (auth)

**28877** MEGAWATT H-V DC POWER SUPPLIES. Reinhold, G.; Gleyvod, R. (Emile Haefely and Co., Ltd., Basel). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1289-1292(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

For the injection of heavy, multiply charged ions into accelerators or for injection of cluster ions into fusion reactors, physicists require high-voltage dc power supplies with voltages in the range of 0.5 to 3 MV and currents of the order of several hundred milliamperes, and even amperes. Several power supplies in this range have been built recently, some for particle injectors and some for testing uhv dc transmission line components. In 1974, high-voltage dc power supplies with the following output ratings were completed: 2.5 MV/200 mA, 2.2 MV/200 mA, 1.2 MV/100 mA, and 1.0 MV/120 mA. All power supplies are built according to the symmetrical Cockcroft-Walton generator principle, and are either air-insulated open structures or built into a pressure vessel and insulated with high-pressure sulphur hexafluoride. Based upon theoretical considerations and experience gained with units previously built, it appears feasible to design even more powerful generators. (auth)

**28878** HV DC INJECTORS FOR LARGE HEAVY-ION ACCELERATORS. Truempy, K.; Gleyvod, R.; Reinhold, G. (Emile Haefely and Co., Ltd., Basel). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1293-1295(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

To meet the particular requirements of heavy-ion injection into large accelerators, a new model dc power supply was developed and built. A pair of 320 kV dc injector power supplies was installed in 1973 at the "Gesellschaft fuer Schwerionenforschung" (GSI) near Darmstadt, Germany. These power supplies deliver an electronically regulated preaccelerating voltage for both dc and pulsed modes of operation. An improved bouncer system is used to keep the output voltage constant at pulsed operation. A new analog-digital voltage-regulating device was incorporated into the control facility. The 320 kV injector system has been in operation for more than a year, and performance has been completely satisfactory. (auth)

**28879** PULSED EXTRACTION MAGNET SYSTEM AT THE ZERO GRADIENT SYNCHROTRON (ZGS). Knott, M.; Lewis, L.; Potts, C. (Argonne National Lab., IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1313-1316(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Pulsed operation of six extraction magnets saved $67,000 in FY 75. Conversion of four six-phase supplies involved some unique analog circuitry. A minicomputer operated function generator provides control of up to 20 magnet power supplies with new dI/dt data available every 4 ms. The operator control console has several options which appreciably decrease set up time and decrease operator error. (auth)

**28880** NANOSECOND ELECTRON BEAM GENERATION AND INSTRUMENTATION AT SLAC. Koontz, R. F.; Miller, R. H. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1350-1353(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The present SLAC injector system, including the latest beam chopping equipment, is discussed, and an updated diagram is given. The present equipment can produce almost any mix of chopped and single bunch beams for experimenters with a high degree of multiple beam compatibility. Topics covered include the grid pulsers, the pulse isolation transformers, the resonant choppers, the nonresonant chopper, the synchronization system, and the fast beam monitors. (PMA)

**28881** RECENT ADVANCES IN HIGH VOLTAGE ELECTRON BEAM INJECTORS. Haimson, J. (Haimson Research Corp., Burlington, MA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1354-1357(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A variety of electron gun systems in the 200 to 500 kV range have been placed into linac service during the past five years. These systems were specifically developed to improve the reliability and performance of high power linear accelerators by providing low emittance pulsed electron beams having highly stable flat-top characteristics. Lifetimes considerably in excess of 5000 hours were achieved through the use of low heater power dispenser cathodes, non-intercepting electrodes for control of beam emission and focusing, all-metal and ceramic high temperature brazed dc accelerating columns, and operational vacuum levels of $10^{-7}$ to $10^{-8}$ torr. The design features and performance of several of these systems, including short beam pulse and high duty factor are discussed, and typical beam waveforms and equipment photographs are presented. (auth)

**28882** ZERO GRADIENT SYNCHROTRON BOOSTER INJECTION. Suddeth, D. E.; Kustom, R. L.; Schmitt, D. (Argonne National Lab., IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1488-1491(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Due to the large radial aperture of the Zero Gradient Synchrotron (ZGS), it seems reasonable to stack two booster beam bunches in the radial betatron phase space. This requires some manipulation of timing and intermediate kicks to accomplish the task. Fourth harmonic operation was selected, which fitted best the kicker flux rise times and the injector energy spread. The accelerating voltage frequency will be 5.3 MHz, which gives a beam bunch every 188 ns. The beam length will be 94 ns. (auth)

**28883** PIG SPUTTER SOURCE FOR NEGATIVE IONS. Andersen, H. H.; Tykesson, P. (Univ. of Aarhus, Denmark). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1632-1636(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A PIG discharge, with radial extraction and a separate sputtering cathode placed opposite to the outlet, was built. To increase the yield of negatively sputtered ions, cesium is vaporized into the discharge. Magnetically analyzed spectra of the extracted beams prove, together with other evidence, that the extracted ions are those directly sputtered. Among others, the following analyzed beams were obtained: $C^-$–7 mu A, $F^-$–15 mu A, $Al^-$– 1 mu A, $Al_2^-$–2,0 mu A, $Cl^-$–30 mu A, $Ta^-$–3 mu A, and $Au^-$–56 mu A. With 10 mu A injected into a tandem accelerator, a 2,4 mu A $Au^{++}$ beam was obtained. (auth)

**28884** PROPERTIES OF THE TEXAS A AND M ELECTRON BEAM ION SOURCE. Hamm, R. W.; Kenefick, R. A. (Texas A and M Univ., College Station). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1637-1639(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

An EBIS (Electron Beam Ion Source) is presently being constructed for use on the Texas A and M cyclotron as an external heavy ion source. A description is given of the source, which is nearing completion, including the essential elements, the operating conditions, expected output, and results of initial tests on some of the components. (auth)

**28885** PROGRESS REPORT ON ZERO GRADIENT SYNCHROTRON $H^-$ SOURCE DEVELOPMENT. Fasolo, J. A. (Argonne National Lab., IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1665-1668(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The reliability required of an $H^-$ source for direct or booster injection into a proton synchrotron was demonstrated during several recent tests of Booster I, the developmental booster for the Zero Gradient Synchrotron (ZGS); the minimum pulsed design current of 4 mA at 50 MeV was obtained for the first time during a recent test of direct $H^-$ injection into the ZGS. On the basis of these results and anticipated further improvements in the source, preparations are being made for the permanent installation of a stripper in the ZGS for the conversion of $H^-$ to $H^+$. (auth)

**28886** ROTATABLE COLD CATHODE PENNING ION SOURCE. Mallory, M. L.; Hudson, E. D. (Oak Ridge National Lab., TN). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22; No. 3, 1669-1671(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A rotatable cold cathode Penning ion source was designed and is operating in the Oak Ridge Isochronous Cyclotron (ORIC). Previous sources for positive heavy ions were severely limited in lifetime by cathode sputtering and buildup of sputtered cathode material. The new ion source extends the cathode lifetime by a factor of approximately 6. The source cathodes are discs of tantalum, $\frac{7}{8}$ in. in diameter and $\frac{3}{8}$ in. thick. Upon completion of an ion source burn at one position on the circular edge of the cathode discs, each disc is rotated to an unused position for the next burn. A provision exists for continuous rotation of the cathodes. The plasma collimating holes, where the sputtered cathode tantalum is deposited, also are on discs with six possible positions. The new source resulted in increased accelerated beam currents and greater stability for heavy ions. The source was also used to produce light ion beams (H, D, alpha) over a wide range of intensities. (auth)

**28887** CALCULATED FINITE EMITTANCE AND DEE-GAP CROSSING EFFECTS ON HEAVY-ION TRAJECTORIES OF ION INJECTION INTO THE OAK RIDGE ISOCHRONOUS CYCLOTRON FROM A 25 MV TANDEM ELECTROSTATIC ACCELERATOR. McNeilly, G. S.; Fischer, K. N. (Oak Ridge National Lab., TN). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1682-1684(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Calculational results are presented, which are part of a continuing study to assist in optimizing the geometry and flexibility of the ORIC injection system. The calculated effects of finite emittance and dee-gap crossings during ion injection on beam size and quality at the stripper foil are presented. (auth)

**28888** ION SOURCE AND THE INTERNAL BEAM CURRENTS OF THE CS-15 COMPACT CYCLOTRON. Kuo, T. Y. T.; Lee, R.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1711-1714(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Sloan-Kettering Institute CS-15 compact cyclotron was the first prototype built by the Cyclotron Corporation in 1967. The ion source is a cold cathode PIG type radially fitted into the 4-inch magnet gap. The ion source is simple, small, and capable of delivering large currents, but causes certain problems. For example, the beam current showed large fluctuations from time to time, resulting in unpredictable cyclotron performance. The ion source was operated with limited configurations, and beam current could only be adjusted by changing rf dee voltage. It was discovered that the power density of the arc column plays an extremely important role in determining ion source performance. (auth)

**28889** PENNING ION SOURCE IN A 7-MV VAN DE GRAAFF. Arndt, P.; Jenter, W.; Mahnke, H. E. (Institut fuer Kernforschung, Berlin). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1715-1717(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A Penning type ion source with axial extraction was installed in the 7-MV Van de Graaff for the production of heavy ions. The source test in the accelerator and beam parameter measurements (currents with emittance and energy spread) proved the source to be adequate for the accelerator combination VICKSI. (auth)

**28890** BEAM-MATCHING SYSTEM BETWEEN PRE- AND MAIN-ACCELERATOR FOR THE VAN DE GRAAFF-CYCLOTRON-COMBINATION VICKSI. Hinderer, G.; Maier, K. H. (Hahn-Meitner-Institut, Berlin). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1722-1725(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The matching system connects the Van de Graaff preaccelerator with the isochronous split pole cyclotron of the heavy ion accelerator combination VICKSI and prepares the beam for injection into the cyclotron. The charge state of the ions is increased by a stripper (gas or carbon foil). The beam stripping, however, enlarges the phase space occupied by the beam due to angle and energy straggling. To minimize this deterioration of beam quality, a sharp focus at the stripper is provided in all three dimensions. A longitudinal (time) focus, both at the stripper and in the center of the cyclotron, is achieved by means of two identical klystron-type bunchers. The magnetic focusing system between the two bunchers contains two doubly achromatic bending units of 90 degrees. Telescopic focusing is used before the stripper and after the stripper to the second buncher. The last section just before the cyclotron comprises one more bending unit and several quadrupoles for dispersion matching and adapting the horizontal and vertical phase space for injection. (auth)

**28891** EXPERIMENTAL RESEARCH OF THE CLOSED ORBIT EXPANSION EFFECT IN THE STRONG FOCUSING CYCLOTRON. Vasilenko, A. T.; Glazov, A. A.; Dzhelepov, V. P.; Dmitrievsky, V. P.; Denisov, Yu. N.; Zamolodchikov, B. I.; Zaplatin, N. I.; Kalinishenko, V. V.; Kolga, V. V.; Novikov, D. L.; Onischenko, L. M.; Polumordvinova, N. I.; Samsonov, E. V.; Shishlyannikov, P. T. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1862-1865 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A theoretical and experimental study of a beam extraction method using the closed orbit expansion effect is described. The steep gradient of the magnetic field is used to change the momentum compaction factor for the limit radial area. The orbit separation is found by solving the dynamic equations, since the behavior of the betatron oscillation frequencies and the beam phase are investigated in this radial region. The experimental study of the effect is carried out with the ring cyclotron electron model, which is a strong focusing, eight sector, isochronous cyclotron. Calculated orbit separation in the extraction area is about 2 to 4 cm. The magnet system used to obtain the proper gradient of the magnetic field and the magnet measurement results are described. The measured value of the orbit separation equals 4 cm. At the same time, the space between two orbits without current (free of particles) is about 2 cm, and the full current on the separated orbit is equal to that before separation. The theoretically predicted beam phase shift is found to be equal to from 30 to 40°. The results obtained confirm the possibility of 100 percent beam extraction from the accelerator with space magnetic field variation. (auth)

**28892** 200-MHz DEBUNCHER FOR THE FERMILAB INJECTOR. Owen, C. W.; Gray, E. R.; Johnson, D. E.; Lee, G. M.; Ohnuma, S.; Winje, R. A. (Fermi National Accelerator Lab.,

Batavia, IL). IEEE (Inst. Electr. Electron. Eng.). Trans. Nucl. Sci.; NS-22: No. 3, 1904-1905(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The debuncher was installed primarily to reduce the effects of space charge forces, but there is an additional very great advantage to its use. It automatically corrects small errors in mean momentum from the linac and, as a result, makes it possible to operate the linac at higher currents than would be allowed without the debuncher. The Fermilab debuncher is a three-cell Alvarez structure, very similar in design and construction to the Fermilab 200-MeV linac. (auth)

## Ion Optics and Field Calculations

**28893** (COO-3072-38) DETECTION OF FORWARD PARTICLES AT HIGH LUMINOSITY INTERSECTION REGIONS OF POPAE. Bjorken, J.; Chang, C.; Mockett, P.; Shoemaker, F.; Sulak, L.; Teng, L. (Princeton Univ., N. J. (USA). Dept. of Physics). Nov 1974. 10p. (CONF-741159-1). Dep. NTIS $4.00.

From POPAE study group; Batavia, Illinois, USA (7 Nov 1974).

Quadrupole magnets and other beam transport elements located near the high-luminosity intersection regions at POPAE are discussed with respect to keeping all potentially interesting regions of phase-space accessible to experimental investigation. A possible design and features for a single arm spectrometer located about 40 m downstream along one of the intersecting rings are presented, including expected mass resolution. (PMA)

**28894** (JINR-R-9-8119) CALCULATION OF MULTICHARGED ION ACCUMULATION IN A HEAVY ION ACCELERATOR. Iovnovich, M. L.; Kuznetsov, A. B.; Prejzendorf, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Dept. of New Acceleration Methods). 1974. 11p. (In Russian). INIS.

9 refs.; 4 tables.

Using new ionization cross-section data, calculations were made on the storage of multi-charged ions of a number of elements in a heavy-ion accelerator. The question of cascade potentials of ions in an accelerator is examined. Threshold charges of ions for leakage from the channel of the cascade potential upon acceleration were found. (tr-auth)

**28895** (TRI-PP-75-9) FOCUSING IN RF ACCELERATING GAPS WITH ASYMMETRICALLY CURVED ELECTRIC EQUIPOTENTIALS. Dutto, G.; Craddock, M. K. (British Columbia Univ., Vancouver (Canada). TRIUMF Facility; British Columbia Univ., Vancouver (Canada). Dept. of Physics). Aug 1975. 4p. (CONF-750824-9). Dep. NTIS (US Sales Only) $4.00.

From 7th international conference on cyclotrons and their applications; Zurich, Switzerland (19 Aug 1975).

An analysis is made of the extra focusing that can be obtained by suitably shaping the dee gap, in addition to the usual phase change, velocity gain and strong focusing effects. To obtain this extra focusing, the electric equipotentials must be curved in the median plane; the extra focusing power is shown to be proportional to the integral $\int(d^2y/dx^2)dV$ across the gap of the second derivative of the equipotential curves $y(x,V)$ in the median plane. There is also a complementary relationship between the radial and vertical focal powers of the dee gap; their sum is shown to be proportional to the rate of change of energy gain with phase, provided space charge and transit time effects can be neglected. The application of these theorems to central region design is illustrated by a number of examples. (auth)

**28896** INTEGRAL FORMULATION FOR SECOND-ORDER ABERRATION COEFFICIENTS OF LONGITUDINAL PROPERTIES OF A LINAC. Takeuchi, Y.; Fujioka, H.; Ura, K. (Osaka Univ., Suita (Japan). Faculty of Engineering). Nucl. Instrum. Methods; 126: No. 3, 361-368(15 Jun 1975).

The relative energy variation and the phase width of electron beams in a high-energy-resolution LINAC are approximated to the second order by perturbation calculations. The second order longitudinal aberration coefficients for the above beam properties are formulated in the integral form. The second order longitudinal aberration for the relative energy variation becomes important at the optimum injection phase where the maximum acceleration is attainable. The integral-formation method for calculating the second-order longitudinal aberration coefficients is much faster than the ray-tracing method. A numerical example of a high-energy-resolution LINAC is presented. (auth)

**28897** USE OF COHERENT ELECTRON-PAIR PHOTOPRODUCTION AND BREMSSTRAHLUNG OBTAINED FROM A 400 GeV PROTON–SYNCHROTRON. Diambrini–Palazzi, G.; Menichetti, E.; Santroni, A. (Genoa Univ. (Italy). Istituto di Scienze Fisiche). Nucl. Instrum. Methods; 126: No. 3, 369-372(15 Jun 1975).

The coherent electron-pair production by very-high-energy photons in a crystal converter can be used to obtain a cleaner electron beam from the CERN SPS or Batavia 400 GeV proton synchrotron. Coherent electron-pair cross section in a tungsten crystal was integrated over the photon energy spectrum which fits the inclusive reaction ISR data. Performances of several crystals were evaluated before selecting the tungsten crystal. (auth)

**28898** PULSED BREMSSTRAHLUNG SPECTRUM MEASUREMENT USING A FAST SCINTILLATOR. Narita, M.; Ozawa, Y. (Hokkaido Univ., Sapporo, Japan). Mem. Fac. Eng., Hokkaido Univ.; 14: No. 1, 125-133(Mar 1975).

The energy spectrum of pulsed bremsstrahlung from a 4-MeV electron linac was measured using a plastic scintillator and an electric integral system. The measuring system, consisting of a 100 MHz discriminator, an integrator, and a multichannel PHA for a scaler, works as a single channel pulse height analyzer which made it possible to separate multiple photons detected during a single linac pulse width. From the measured pulse height distributions, the spectrum of pulsed radiation source is deduced by the use of numerical unfolding techniques. (auth)

**28899** SINGLE PARTICLE AND COLLECTIVE EFFECTS OBSERVED IN THE ELECTRON BEAM OF THE MARYLAND ERA EXPERIMENT. Destler, W. W.; Hudgings, D. W.; Kehs, R. A.; Misra, P. K.; Rhee, M. J. (Univ. of Maryland, College Park). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 995-998(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The formation of rotating, relativistic electron beams with properties suitable for collective ion acceleration was studied under a variety of experimental conditions. A straight, cylindrical, relativistic electron beam (typical energy 2 to 3 MeV, typical current 2 to 10 kA) is passed through a narrow magnetic cusp, and the resulting rotating downstream beam is studied using a number of diagnostic techniques. Two current regimes were investigated, one in which the self-fields of the downstream electron beam are small compared to the applied fields, and one in which the self-fields are comparable to the applied fields. The beam characteristics in both regimes were compared to single particle expectations. Experiments were also conducted in which the effect of an inner and outer conducting boundary on the time-resolved beam cross section was measured. Results are discussed in the context of collective ion acceleration experiments now in preparation. (auth)

**28900** NUMERICAL SIMULATION OF THE ACCELERATION OF ION-LOADED ELECTRON RINGS. Greenwald, A. C.; Reiser, M. P. (Univ. of Maryland, College Park). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 999-1002(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Numerical studies were performed to simulate the acceleration of ion-loaded electron rings by the magnetic expansion method. A finite-sized multi-particle code was used, which computes particle-particle interaction forces directly and approximates conductive boundaries. Initial conditions are electron-ion rings in equilibrium, trapped in a magnetic mirror. On one side, the magnetic field is reduced in time, allowing the ion-loaded ring to move into a region of expansion acceleration. The calculations show that the use of a "squirrel-cage" type conductor inside the beam, which suppresses azimuthal magnetic image currents, assures sufficient axial focusing to retain the integrity of the ring. (auth)

**28901** RECTILINEAR TRANSITION FLOW OF INTENSE CHARGED PARTICLE BEAMS. Chodorow, A. M. (Mission Research Corp., Albuquerque, NM); Erteza, A. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1016-1018(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Charged particle flow in planar geometry is generally classified into two phenomenological regimes. At relatively low current injection densities (less than a critical function of length and potential across the drift space and entrance kinetic energy), all charges propagate across the entire region, and the flow is termed injection limited. Space charge limited flow occurs at supercritical injection densities, and is characterized by partial particle reflection at the plane of minimum kinetic energy. Solutions of the laminar, monoenergetic beam equations demonstrate the existence of a transition region, rather than a single critical current density, in which either flow may exist. (auth)

**28902** TWO-DIMENSIONAL INTENSE RELATIVISTIC BEAM EQUILIBRIUM. Chodorow, A. M. (Mission Research Corp., Albuquerque, NM); Erteza, A. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1019-1021(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The behavior of an intense relativistic charged particle beam is studied by determining a two-dimensional equilibrium solution of the laminar flow, monoenergetic particle dynamics equations. With these relations formulated in azimuthally symmetric cylindrical coordinates, the free parameter method is used to derive the most general similarity variable eta(r,z) appropriate to the equations, and an exact solution is found in terms of this unknown. The solution is interpreted as a force-free converging or diverging particle beam propagating in the z direction within a conical drift chamber. (auth)

**28903** SCALING STUDIES OF COLLECTIVE ION ACCELERATION WITH INTENSE RELATIVISTIC ELECTRON BEAMS. Miller, R. B.; Straw, D. C. (Air Force Weapons Lab., Kirtland AFB, NM). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1022-1025(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Recent experimental observations of collective ion acceleration, produced when an intense relativistic electron beam is injected into a low pressure neutral gas, have firmly established a threshold beam current for the process. For this geometry, ion acceleration does not occur unless the electron beam current (I) exceeds the space-charge limiting current (I/sub l/). Additional observations of ion acceleration were obtained in two series of experiments. In the first series, the guide tube and diode configuration provided a large ratio of injected beam current to space charge limiting current, and drift tube endplate effects were examined. When the separation between the anode and tube endplate became less than the drift tube diameter, the efficiency of the collective acceleration process was strongly reduced. In the second series of experiments, the scaling of accelerated ion energy with electron beam kinetic energy was investigated using two electron beam machines which differed in stored energy by a factor of approximately 20. Using the larger machine, proton energies in excess of 16.5 MeV were attained. An expression is presented for the optimum pressure for ion acceleration in the drifting beam neutral gas geometry. (auth)

**28904** ON BEAM BLOWUP IN A RACETRACK MICROTRON. Volodin, V. A.; Hanson, A. O. (Univ. of Illinois, Urbana). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1194-1196(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A preliminary theoretical study is reported of the interaction of electromagnetic fields in the accelerating structure of a racetrack microtron with the transverse motion of electrons circulating through the structure. Basic equations of the transverse beam dynamics and of buildup of the deflecting modes are derived with the help of idealized models of a microtron as well as of the beam-structure interaction process. The dependence of the starting current for beam blowup on the parameters of the accelerator was studied, and some features of the Microtron Using a Superconducting Electron Linac (MUSL-2) of the University of Illinois were taken into account to make numerical calculations. It was shown that the starting current is extremely sensitive to the phase correlation between the returning beams and, under some conditions, can be much lower than that for a linac. The use of the thin magnetic lenses on each orbit helps to achieve higher values of the starting current. (auth)

**28905** EFFECTS OF SPACE CHARGE AND REACTIVE WALL IMPEDANCE ON BUNCHED BEAMS. Hansen, S.; Hereward, H. G.; Hofmann, A.; Huebner, K.; Myers, S. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1381-1384(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Space charge and reactive wall impedance create longitudinal forces inside the bunch which change the incoherent phase oscillation frequency, the bunch length, and the size of the rf-bucket. These effects were investigated with bunched beams in the ISR. By measuring the shift of the quadrupole mode phase oscillation frequency, the strength of the self-forces was determined. The inductive wall is dominant, and its impedance (divided by the mode number) was measured to be parallel Z parallel/n approximately 26 Ohms. An increase of bunch length with current was measured, which can be explained by the inductive impedance up to a certain current; beyond that, an excessive, unexplained bunch lengthening occurs. The reduction of the bucket size affects the stacking process. By correcting for this effect, an increased density of the stacked beam was achieved. (auth)

**28906** TUNE SHIFTS OF EXCENTRIC BEAMS IN ELLIPTIC VACUUM CHAMBERS. Zotter, B. W. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1451-1455(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

High-energy particle accelerators and storage rings require a close control of the betatron tune in order to avoid beam blow-up and particle loss by nonlinear resonances. For this reason, one needs a good knowledge of the tune shifts caused by space-charge forces. These are conventionally separated into one contribution due to the "direct" space-charge force, which remains unchanged when the chamber walls are removed, and one due to "image" effects caused by the presence of surrounding walls, and which usually dominate at higher energies. Image coefficients, which are proportional to derivatives of forces acting on the beam, are calculated for circular and elliptical chambers and for parallel plate geometry. The direct space charge coefficients are also calculated, and the incoherent Q-shift of a stacked beam is discussed. For circular chambers, which are usually proposed for future superconducting machines, the image coefficients can become quite large for excentric beams. (PMA)

**28907** POSITIONING TOLERANCES OF BEAM LINE MAGNETS. Carey, D. C. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1537-1539(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The positioning tolerances of magnets are an important consideration in the design and installation of a beam line. A misaligned magnet can both shift the beam centroid and affect the beam line transmission characteristics. To first order and without misalignments, the coordinates at any point of a beam particle are given as a transfer matrix times the initial coordinates. To this is added a term linear in the misalignment parameters, giving the beam centroid shift, and a term bilinear in the initial particle coordinates and the misalignment parameters, giving the effect on the beam focal properties. This formalism has been incorporated into the computer program TRANSPORT. The effect of either a known misalignment or an uncertainty in position may be exhibited. In a single run, up to ten magnets may be separately misaligned, and their separate effects on the beam coordinates printed in a table. (auth)

**28908** BEAM CALCULATIONS FOR LAMPF MUON CHANNEL. Lysenko, W. P. (Yale Univ., New Haven); Hughes, V. W.; Ohnuma, S.; Thompson, P. A.; Vogel, H. F. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1593-1597(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Calculations are described of the beam properties of the stopped muon channel at LAMPF with emphasis on work done during 1974 which was helpful in tuning the muon channel for maximum performance and for understanding the channel behavior. Comparison with actual channel performance during this period and some notes on the computer programs used are also presented. (auth)

**28909** IUCF TRANSFER BEAMLINE. Devins, D. W.; Pollock, R. E.; Hicks, J. W.; Foster, C. C. (Indiana Univ., Bloomington). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1601-1604(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The transfer beamline between the injector stage and main stage cyclotrons was designed and constructed, and is under test. The beamline provides a good match between the calculated extracted phase space ellipses in the injector and the inflection requirements of the main stage over a wide range of particle types, emittances, and energies. Energy dispersion of 0.07 percent FWHM for 16 MeV protons is available at a waist. Attempts were made to minimize time dispersion; as a result, the time spread through the transfer system is negligible for light ions. For $^{12}C(4+)$, the time spread will cause an energy spread in the main stage at 200 MeV of about 100 keV under normal operating conditions. (auth)

**28910** BEAM BUNCHING, A PROPOSAL FOR PRODUCING PICOSECOND ELECTRON PULSES. Hutton, A. (Laboratorio FRAE, Bologna). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1617-1620(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A new method of producing single fine structure pulses of electrons is presented. A prebuncher operating at a whole number

fraction of the fundamental (3/4, 5/6, etc.) is used. Electrons will only be accepted when the prebuncher is in phase with the buncher, this condition occurring at the beat frequency. Stray electrons preclude the use of this simple system in a high current linac, but use of a wide band travelling wave prebuncher, powered at the fundamental and beating frequency simultaneously, produces even better results. Detailed calculations which predict the performance of the system are presented. (auth)

**28911** PERFORMANCE LIMITATIONS IMPOSED BY BEAM DYNAMICS. Teng, L. C. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1826-1832(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The two most basic parameters characterizing the performance of accelerators and storage rings are the beam energy and the beam current. Except in accelerators employing collective field acceleration schemes, the beam energy is limited by rather elementary factors, namely the size of the machine and the attainable field intensities. Non-trivial mechanisms limiting the beam current are reviewed and are discussed in an intuitive physical manner with the full understanding that such discussions cannot be rigorous and precise. General mathematical methods are discussed only in a qualitative manner. For quantitative treatments and results the reader is directed to the references. As a rule, the discussions are centered on circular proton machines, although in many cases they are applicable also to linear or electron machines. (auth)

**28912** BUNCH SHAPE OSCILLATION CONTROL IN RF TRAPPING. Gumowski, I.; Zanaschi, D. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1847-1851(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The bunch formation generally produces an oscillatory time-behavior of the longitudinal charge density, which is reproduced synchronously in the coherent self-field. The resulting beam behavior, caused by the space-charge feedback, tends to convert single-peaked bunches into double-peaked ones (as seen on a sum pick-up electrode). The beam is analyzed, using as parameters the energy spread of the unbunched beam, the beam intensity, and the particle distribution. For given values of these parameters, a theoretical shape of the rf voltage rise V(t) is then obtained by successive approximation, which minimizes bunch shape oscillations without reducing the high trapping efficiency (greater than 90 percent). This V(t) (one to five percent of V/sub max/ for t equals 0) imposes operation under very heavy beam-loading conditions. Experimental results, obtained after the corresponding improvement of the systems performance, are presented and compared with the bunch shapes obtained for equal trapping efficiencies with an iso-adiabatic voltage rise. (auth)

**28913** ANALYTICAL AND COMPUTATIONAL STUDIES OF RESONANCE WIDTH NEAR THE INTERSECTION OF TWO RESONANCES. Ohnuma, S. (Fermi National Accelerator Lab., Batavia, IL); Gluckstern, R. L. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1851-1854(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

When the working point (nu/sub x/,nu/sub y/) lies near the intersection of two sum resonances that arise from the same nonlinear multipole field, the width of each resonance is modified by the presence of the other. Taking the two third-integer resonances, 3nu/sub x/ equals N and nu/sub x/ + 2nu/sub y/ equals N, as an example, an analytical treatment of this problem was developed, and its predictions were compared with numerical results. (auth)

**28914** BEAM DYNAMICS EXPERIMENTS IN THE PS BOOSTER. Gareyte, J.; Magnani, L.; Pedersen, F.; Sacherer, F.; Schindl, K. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1855-1858(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The main problems encountered on the way to $10^{13}$ protons per pulse were emittance blow-up and coherent instabilities. The observations and counter measures are described. (auth)

**28915** LONGITUDINAL INSTABILITIES IN THE FERMILAB 400-GeV MAIN ACCELERATOR. Stiening, R. F.; Griffin, J. E. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1859-1861(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

At beam intensities greater than $8 \times 10^{12}$ protons per pulse, longitudinal bunch instabilities are observed in the Fermilab main accelerator. The oscillations are primarily dipole coherent bunch motion, with small mixtures of higher order modes. The oscillations grow during acceleration to amplitudes of about +- twenty degrees and remain constant at that amplitude, apparently in equilibrium with the Landau damping process. If sufficient bucket area exists, there is no significant beam loss associated with the longitudinal motion, but selective extraction and irregular spill structure occurs. "Mountain range" data on bunch motion and spectrum analysis of Fourier components of the circulating beam indicated that the primary sources of the observed instabilities are resonances with high shunt impedances within the accelerating cavities. Although the rf cavities were already provided with spurious mode damping devices, additional damping systems, consisting of ferrite loaded coaxial waveguide filters, were designed and are being installed on all accelerating cavities. (auth)

**28916** SINGLE BUNCH BEAM LOADING EXPERIMENTS ON THE SLAC TWO-MILE ACCELERATOR. Koontz, R. F.; Loew, G. A.; Miller, R. H. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1870-1874(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Several experimental improvements were used in the generation of new data on the dependence of single bunch radiation loss as a function of energy. These results are given, along with an empirical theory to explain these results. The experimental technique used is reviewed. (PMA)

**28917** MEASUREMENT AND INTERPRETATION OF COUPLING IMPEDANCE DATA IN THE FREQUENCY AND TIME DOMAIN. Umstatter, H. H. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1875-1877(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In order to prevent beam instabilities due to the coupling impedance of vacuum tanks containing septum magnets, electrostatic inflectors, etc. in a proton synchrotron, routine measurements were made using portable instruments before installation. For frequencies greater than 20 MHz, the physical size of the devices is comparable to lambda/4 (the typical problem of microwave measurements), and impedance transformations by Carter- or Smith-Charts or computers are needed to obtain the true impedances. Therefore the measurement of reflection and transmission coefficients (S-parameters) is preferable, because their magnitude is invariant along a transmission line. A center conductor of 1 cm diameter, placed in our standard vacuum pipe, forms a 125 OMEGA coaxial line. If a non-standard vacuum tank is inserted, one observes reflection and transmission coefficients. To save the laborious impedance transformations in the frequency domain, the reflected and transmitted waveforms are photographed in the time domain. Their interpretation in terms of frequency dependent impedances is discussed. (auth)

**28918** HIGHER ORDER MULTIPOLE MAGNET TOLERANCES. Chao, A. W.; Lee, M. J.; Morton, P. L. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1878-1880(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Due to field impurities in the magnets in a storage ring or circular accelerator, the values of the betatron frequencies for a given particle in a beam are dependent upon the energy and betatron amplitude of the particle, as well as the values of the energy dispersion and betatron functions at the magnets. A method was developed for finding the values of the betatron frequencies for any particle with given field impurities. This method was used to study the quality of several preliminary designs of some of the quadrupole magnets in PEP by comparing the variations of the betatron frequencies over the maximum expected range of values of the particle energy and betatron amplitude. The expressions for the values of betatron frequencies as functions of the various beam and machine parameters are derived, some of the results for the evaluation of two types of the PEP magnets are presented, and a discussion of these results is given. (auth)

**28919** COMPUTER SIMULATION OF THE INTERACTION OF A SUPERCONDUCTING SYNCHROTRON MAGNET GOOD FIELD REGION WITH A PARTICLE BEAM. Green, M. A.

(Univ. of California, Berkeley). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1881-1884(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The results of several magnetic field calculation computer programs can be combined to form a single graphical representation of magnetic field quality within the aperture of a superconducting accelerator magnet. The graphical technique can be applied on a magnet by magnet basis over a range of current excitations. The value of such graphics, when the accelerator beam profile is shown within the simulated magnet bore, is discussed. (auth)

**28920** PRESSURE INDUCED BEAM INSTABILITIES IN THE FERMILAB ACCELERATOR. Prichard, B. A. Jr. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1884-1886(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Beam instabilities resulting from localized pressure bumps in the Fermilab main ring have become more significant as the beam intensity has increased. The instability threshold depends on pressure, beam intensity, and machine tune. Experiments are described which explore this threshold using both time dependent and time independent pressure bumps. The effects of gas variations, bump length, and time duration are reported. (auth)

**28921** FIELD MAPPING OF THE IUCF 200 MeV CYCLOTRON. Friesel, D. L.; Sinclair, J. W. D.; Bardin, B. M.; Pollock, R. E. (Indiana Univ., Bloomington). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1887-1890 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Magnetic field mapping of the Indiana main stage cyclotron is performed on a Cartesian grid using a 4 by 4 array of Hall probes. The apparatus, driven by torque motor-assisted, high-speed stepping motors, maps one eighth of the cyclotron beam area in 6 hours. Positioning accuracy is maintained by encoders attached to the stepping motor drive shafts, and absolute probe locations are determined using magnetic fiducials on the magnet pole tip. The mapper is interfaced to a digital computer for automatic position control and for field data acquisition, reduction, and storage. On-line data reduction includes conversion of Hall voltages to field values, allowance for individual differences in the sensitivity and non-linearity of the probes, and corrections in the fields for measured errors in the relative probe positions. Examples of the field data quality obtained are presented. (auth)

**28922** FIELD MAPPING RESULTS OF THE IUCF 200 MeV CYCLOTRON. Friesel, D. L.; Pollock, R. E. (Indiana Univ., Bloomington). IEEE (Inst. Electr. Electron. Eng.). Trans. Nucl. Sci.; NS-22: No. 3, 1891-1894(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Indiana University 200 MeV Isochronous Cyclotron is a separated sector (N equals 4) machine whose design goals include the acceleration of both protons and heavy ions over a variable energy range up to a maximum energy of approximately 220 $Z^2/A$ MeV. A set of gradient coils having the optimal geometry was fabricated for use in the field measurement program in one of the cyclotron sectors, with main magnet and trim coil excitations up to their full design values. An extensive series of two-dimensional field maps was obtained to verify the design of the coil set and to provide the data necessary to investigate the orbit dynamic properties of the cyclotron. Results are presented of the field data as they pertain to the trim coil design, in particular, those aspects of the fields other than the predictable relativistic shape changes which influence the coil design in this type of cyclotron. Some results illustrating the range of isochronous field profiles made available by the coil set are also presented. (auth)

**28923** ISOCHRONIZATION CALCULATIONS FOR THE INDIANA UNIVERSITY CYCLOTRON. Jones, W. P. (Indiana Univ., Bloomington). IEEE (Inst. Electr. Electron. Eng.). Trans. Nucl. Sci.; NS-22: No. 3, 1895-1896(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750355-.

A series of calculations using measured magnetic fields was performed to determine the optimal gradient coil currents for the wide range of operating conditions to be experienced by the Indiana University main stage cyclotron. Depending on the particle type to be accelerated and final energy desired, the required radial field increase varies from 0.5 percent to 22 percent. An iterative least squares fitting technique is used to minimize orbit time variations. For the acceleration of 200 MeV protons (330 revolutions, fourth harmonic), the maximum phase excursion is predicted to be less than two rf degrees. The technique used can be adapted to using measured phase histories to predict corrections to gradient coil currents. (auth)

**28924** LONGITUDINAL BEAM MOTION IN THE FERMILAB BOOSTER ACCELERATOR. Gray, E. R.; Hubbard, E. L.; Mills, F. E.; Owen, C. W.; Peters, R. E.; Ruggiero, A. G.; Shea, M. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1897-1899(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The intensity of the Fermilab booster accelerator is limited in part by longitudinal effects. These include longitudinal space charge blowup prior to rf capture, phase space dilution during capture, and insufficient voltage to provide bucket area to accelerate the diluted beam. Measurements of beam properties under these conditions, as well as high intensity effects during acceleration, are presented. (auth)

**28925** TRANSVERSE BEAM MOTION IN THE FERMILAB BOOSTER ACCELERATOR. Gray, E. R.; Hubbard, E. L.; Mills, F. E.; Owen, C. W.; Peters, R. E.; Ruggiero, A. G.; Shea, M. F. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1900-1903(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Measurements are presented of the transverse properties of the booster synchrotron. The principal transverse limitations to operational performance are due to restricted aperture and improper multiturn injection. In addition to these features, working point, chromaticities, high-intensity effects, and injection matching are discussed. (auth)

**28926** BEAM LOADING EFFECTS IN THE CERN PS BOOSTER. Pedersen, F. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.). Trans. Nucl. Sci.; NS-22: No. 3, 1906-1909(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

At intensities greater than $1.5 \times 10^{12}$ protons per ring, and at reduced rf voltage, fast growing beam loading instabilities occur in the Booster (PSB) with loss of beam bunching. The observed thresholds are reported; they are different from those given by Robinson's criterion and occur with a different frequency. To explain this and other observations, a model of the beam loading interaction, including the feedback loops controlling rf amplitude and phase and cavity tuning, is presented. In the general case, beam loading causes cross-coupling between all three loops, which for high beam loading makes the system unstable. For low beam loading, which was assumed for the basic systems design, the loops are practically independent. The Robinson criterion is a limiting case of this model (no feedback loops). A method for designing better loops, taking into account the cross-coupling, is described. Other methods, such as lowering of the cavity Q or feeding the cavity with a current equal to the beam current but of opposite phase, require extra rf power. (auth)

**28927** SEPARATE SECTOR CYCLOTRON BEAM DYNAMICS WITH SPACE CHARGE. Chabert, A.; Luong, T. T.; Prome, M. (GANIL Study Group, Orsay, France). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1930-1933(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Essentially, the goal of the GANIL project is to produce intense beams of ions from Carbon to Uranium with a maximum energy of 100 MeV/amu for Carbon and 8 MeV/amu for Uranium. The heart of the project consists of two separate sector cyclotrons, SSC1 and SSC2, working in series. The desired energy spread of the accelerated beam is $4.10^{-4}$ for light ions and $10^{-3}$ for Uranium. Such a requirement together with requirements on beam transverse emittances made it clear that beam dynamics in these machines be thoroughly studied. The beam dynamics codes which were devised for simulating the behaviour of the cyclotrons and some of the results already obtained are discussed. (auth) (auth)

## Storage Rings

*Refer also to abstracts 28791, 28905, 28906, and 28918.*

**28928** (BNL-20330) THERMAL DESORPTION OF GASES FROM ALUMINUM ALLOY Al 6061: THEIR RATES AND ACTIVATION ENERGIES. Halama, H. J.; Herrera, J. C. (Brookhaven

National Lab., Upton, N.Y. (USA)). 1975. 17p. (CONF-751023-3). Dep. NTIS $4.00.

From 22nd national vacuum symposium; Philadelphia, Pennsylvania, USA (28 Oct 1975).

The use of aluminum in the construction of vacuum chambers for intersecting proton storage rings has several advantages over the use of stainless steel. Ultrahigh vacuum studies were made on long pipes made of aluminum alloy 6061 to determine if this material could be used in the proposed proton intersecting storage accelerator facility, ISABELLE, at Brookhaven. The outgassing rates, measured by two different methods, are compared for several surface treatments and three bake-out temperatures. The lowest outgassing rate of less than 1 x $10^{-14}$ Torr liter $cm^{-2}$ $sec^{-1}$ was obtained with argon and oxygen discharge cleaning. The residual gas in the pipe contained more than 99 percent $H_2$ with traces of CO and $CO_2$. The temperature dependence of the desorption of these gases gave measurements of the heat of diffusion of $H_2$ (E/sub $H_2$/ equals 10.5 +- 1.0 kcal/mol) and the thermal activation energies of CO (E/sub CO/ equals 29 +- 2 kcal/mol) and $CO_2$ (E/sub $CO_2$/ equals 25 +- 2 kcal/mol). Argon, with a peak desorption at 280 to 300°C, also appears to be embedded in the metal. Since all commercially available UHV equipment uses stainless steel flanges, an investigation was made of the behavior of stainless steel to aluminum transitions up to 350°C. (auth)

**28929** (BNL-20453) LOW ENERGY STACKING RING FOR HIGH ENERGY STORAGE ACCELERATORS. Month, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 21 Aug 1975. 10p. Dep. NTIS $4.00.

The use of stacking ring at low energy to achieve high currents in high energy accelerators is proposed. This technique circumvents the high frequency longitudinal instability of the injected bunches, which tends to result in the large circumference machines required for high energy proton storage. A practical example of a stacking ring using small gap, conventional, room temperature magnets, which is suited to the ISABELLE storage accelerators, is presented. Placed in the AGS tunnel, this ring could also be used as a "physics stretcher". The small gap property, tending to minimize power consumption and cost, also introduces strong image space charge fields. It is concluded that currents even as high as 10 A could be accumulated in such a stacking ring. Aside from the primary reason for the stacking ring, some other benefits for the ISABELLE project are discussed, and some implications for storage ring stacking in general are included. (auth)

**28930** (KFTI-74-30) EXTERNAL DISTURBING FORCE METHOD FOR CHANGING BEAM PARAMETERS IN CHARGED PARTICLE STORAGES. Bulyak, E. V.; Tolstoj, A. E. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 15p. (In Russian). INIS.

12 refs.; 1 table; 3 figs.

Different methods are compared for increasing the transverse dimensions of a beam in an accumulator in order to increase the maximum stored current. It is shown that dispersion of betatron frequency increases with an increase in the central frequency of the noise field activated in the beam. A computer program is described which models the behavior of a beam upon activation of ultra-high-frequency noise. (tr-auth)

**28931** STORAGE ACCELERATOR BENDING MAGNET WITHOUT MEDIAN PLANE SYMMETRY. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, NY). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1188-1189 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

An H-magnet with no median plane symmetry, in which all the current carrying coils lie below the median plane was studied using the GRACY magnet program. This magnet has several possible advantages for use in a superconducting storage accelerator. The field multipoles violating median plane symmetry were found to be small, and correctable with small correction coils. In addition, it was found possible to reduce these undesired multipoles considerably by shaping the iron pole face. (auth)

**28932** FERMILAB HIGH-FIELD OPTION POPAE DIPOLE: MAGNETOSTATICS. Snowdon, S. C. (Fermi National Accelerator Lab.; Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1204-1205 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Magnetic field computations were performed for a four-inch coil aperture 45 kG dipole magnet that may be used in a high-field option of POPAE. A cold iron version utilizing flat pancake coils was explored to determine the magnetostatic effectiveness of a simple coil geometry. Suitable locations were found for rectangular blocks of conductors each consisting of 280 turns of .040 in. by .040 in. conductor. (auth)

**28933** HIGH EFFICIENCY, CW, HIGH POWER KLYSTRONS FOR STORAGE RING APPLICATIONS. Konrad, G. T. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1249-1252(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The 125 kW c-w klystrons were specifically designed for energy upgrading of the electron-positron storage ring, SPEAR II, at SLAC. Four tubes are required with an efficiency greater than 50 percent. The operating frequency is 358.54 MHz. The gain is approximately 50 db, the operating voltage is 41 kV, and the microperveance is 0.7. The klystron must be stable when working into an accelerator cavity VSWR as high as 2:1 at any phase angle. The calculated and experimental data to be presented include saturation and phase characteristics. A maximum efficiency of 57 percent was obtained, and the highest output power was 160 kW c-w at 42.5 kV. The design of a higher power version of this tube is presented. The rf power is 500 kw c-w at an efficiency exceeding 70 percent. The operating voltage and current are 62 kV and 11.5 A, respectively. The higher efficiency is obtained by inserting an additional cavity to make use of second harmonic bunching. Eighteen such klystrons are to be used in the proposed PEP storage ring. (auth)

**28934** 40 kA DUMPING SYSTEM FOR THE ISR BEAMS. Schnuriger, J. C. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1321-1323(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The kinetic energy of the proton beam of each ISR is W equals I x E x T/sub rev/. With the maximum value of current achieved so far in the ISR I approximately equal to 30 A, a proton energy E equals 26 GeV, and a revolution time T/sub rev/ equals 3.15 mu s, the result is a maximum kinetic energy of W equals 2.45 MJ. Such an energy, if suddenly lost and instantaneously dissipated in any part of the ISR, would cause a major breakdown. It was therefore necessary to build a fast and reliable system which could dump the beam whenever safety monitors indicated a hardware fault or a beam loss. The beam in each ISR is dumped by means of four fast pulsed magnets deflecting the particles vertically onto an absorber block situated in the same long straight section. In 1970, when the ISR was first put into operation, each of the four magnets in each ring was energized independently by its own 3 OMEGA pulse generator. By means of a special spark-gap developed for that purpose, and by switching together the four 3 OMEGA pulse-forming networks, it was possible to improve significantly the reliability of the system. The 0.75 OMEGA, 40 kA pulse generator now energizing the four fast pulsed magnets is described, with special attention given to the principles and technological solutions which were adopted in order to achieve the necessary reliability of the system for each type of operation, particularly during long colliding beam experiments. (auth)

**28935** REPORT ON THE ISR. Schnell, W. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1358-1362(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Operation and experimental productivity during 1974 at the CERN intersecting proton storage rings are summarized, and the performance limits and beam behavior are discussed. A peak luminosity five times above the original design aim was attained, and no fundamental limit seemed to be reached. Transverse emittance, background radiation, and beam decay are also discussed. (PMA)

**28936** REPORT ON DORIS. Voss, G. A. (Deutsches Elektronen-Synchrotron, Hamburg). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1363-1365(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Operational characteristics are described for the double storage ring DORIS, which has been in operation since the beginning of 1974. Colliding beam experiments started in November of 1974. Luminosities of $10^{30}$ $cm^{-2}$ $s^{-1}$ at 2 GeV are routinely reached during experimental runs. Beam life times are 8 to 11 hours. At the present time luminosity is limited by phase instabilities. (auth)

**28937** SPEAR II PERFORMANCE. Paterson, J. M. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1366-1369(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The single beam and colliding beam performance of the SLAC electron-positron storage ring SPEAR II is described. The sevenfold increase in harmonic number in SPEAR II in comparison to SPEAR I has made significant changes in single beam behavior. Strong synchrobetatron resonances and a new transverse instability are observed, and our first studies of these phenomena are described. Measurements on current dependent bunch lengthening are presented. (auth)

**28938** EFFECTS OF A NON-LINEAR LENS ON THE STORED PROTON BEAM IN THE ISR. Keil, E.; Leroy, G. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1370-1373(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In order to simulate the beam-beam effect in a proton storage ring at values of the beam-beam tune-shift much higher than those attainable with proton beams in the ISR, a non-linear lens was installed. It consists of a pair of bars inside the vacuum chamber about 1 m long, capable of carrying currents up to 1000 A, which corresponds to a linear tune-shift of about 0,1. The current bars, running parallel to the beam at a distance of a few mm above and below it, create a highly non-uniform magnetic field. It has the same symmetry as space charge at a head-on intersection, and excites all nonlinear resonances n/sub h/Q/sub h/ + n/sub v/Q/sub v/ equals p for which both n/sub h/ and n/sub v/ are even. The beam decay rate has been measured as a function of the betatron tunes and of the tune shift DELTA Q caused by the non-linear lens. When DELTA Q changes between 0 and 0.05, the decay rate changes by about 3 orders of magnitude and depends strongly on the betatron tunes. A computer simulation shows that at DELTA Q approximately 0.05 the stochasticity limit is reached. (auth)

**28939** PETRA, AN EXTENSION OF THE STORAGE RING FACILITIES AT DESY. Voss, G. A. (Deutsches Elektronen-Synchrotron, Hamburg). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1374-1375(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A proposal for the construction of a 19 GeV electron-positron storage ring at DESY was submitted for approval. The circumference of the ring will be 2304m, the bending radius in the magnets 197m, and the maximum luminosity $1.2 \times 10^{32}$ cm$^{-2}$ s$^{-1}$. PETRA will make use of the storage ring DORIS as an intermediate storage facility during injection and the 7 GeV-DESY synchrotron as the injector. (auth)

**28940** PROGRESS REPORT ON THE POPAE DESIGN STUDY. Collins, T. L.; Edwards, D. A.; Igebretsen, J.; Johnson, D. E.; Ohnuma, S.; Ruggiero, A. G.; Teng, L. C. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1411-1415(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

POPAE (Protons on Protons and Electrons) is a storage ring facility at the Fermilab on a scale suitable to permit the collision of 1000 GeV protons with 1000 GeV protons and with electrons of an energy compatible with that scale. A summary is given of the work on the lattice and layout of the proton storage rings. Though the 1000 GeV physical scale is maintained, the design is developed in a 400 GeV context. The proton rings form a racetrack, the two long straight sections of which are each about 1 km in length. Each long straight section contains a number of matched lattice insertions, as well as uncommitted space for additional development. Depending on the assumptions made concerning the beam-beam limit (as yet unknown experimentally), maximum luminosities are calculated to be in the range from $10^{33}$ to $10^{34}$ cm$^{-2}$ sec$^{-1}$. (auth)

**28941** MEASUREMENT OF INTRA-BEAM SCATTERING IN THE ISR. Huebner, K. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1416-1418(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The growth of proton beams coasting for a long time with very low loss-rate was measured. A comparison with the growth-rate expected from intra-beam scattering is presented. At low energy, measured and calculated growth agree. At high energy, the measured growth tends to exceed the calculated one by a factor of about 3. The growth in momentum spread is in accordance with theory. (auth)

**28942** FIRST HIGH-LUMINOSITY INSERTION IN THE ISR. Gourber, J. P.; Keil, E.; Pichler, S. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1419-1422(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

One of the means proposed to increase the luminosity in storage rings, a so-called low-beta insertion, was successfully put into operation in the Intersecting Storage Rings (ISR). The installation of five quadrupoles in each ring around one intersection resulted in a reduction of beam height by a factor 2,3. Due to proper matching, the perturbation to the rest of the machine was negligible. With circulating beams of 20 A and 24 A, a luminosity of $2{,}11 \times 10^{31}$ cm$^{-2}$ s$^{-1}$ was achieved. The results of tests are given, and are compared to theoretical forecasts. A short description of the hardware used is presented. (auth)

**28943** PEP INJECTION SYSTEM. Brown, K. L. (Stanford Univ., CA); Avery, R. T.; Peterson, J. M. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1423-1425(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A system to transport 10 to 15 GeV electron and positron beams from the Stanford Linear Accelerator and to inject them into the PEP storage ring under a wide variety of lattice configurations was designed. Optically, the transport line consists of three $360^0$ phase-shift sections of FODO lattice, with bending magnets interspersed to provide achromaticity, convenience in energy and emittance definition, and independent tuning of the various optical parameters for matching into the ring. The last $360^0$ of phase shift has 88 milliradians of bend in a vertical plane, and deposits the beam at the injection septum via a Lambertson magnet. Injection is accomplished by launching the beam with several centimeters of radial betatron amplitude in a fast bump provided by a triad of pulsed kicker magnets. Radiation damping reduces the collective amplitude quickly enough to allow injection at a high repetition rate. (auth)

**28944** COMPENSATION OF CHROMATIC ABERRATION IN A SINGLE PERIOD LATTICE. Edwards, D.; Ohnuma, S.; Teng, L. C. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1426-1428(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The requirement of high periodicity (even periodicity two) in a storage-ring lattice imposes a strong restriction on the number and type of insertions that can be included. On the other hand, since the insertions are matched only at one momentum, the beta-function error for an off-momentum orbit is generally greater in a one-period lattice. This large beta-error has several undesirable effects. All of these undesirable effects can be compensated or greatly reduced by judicious arrangement of betatron phasing and by the use of trim sextupoles. The design procedure and the resultant performance are demonstrated for a model one-period lattice. (auth)

**28945** CHROMATICITY CORRECTION IN EPIC. Donald, M. H. R.; Harold, M. R.; Maidment, J.; Rees, G. H. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1422-1434(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In order to achieve a high luminosity in EPIC, the proposed UK $e^+$-$e^-$ storage ring, low-beta insertions will be used at each of the four interaction regions. The consequent increase in chromaticity, xi equals (DELTAQ/Q)/(DELTAp/p), must be corrected by means of sextupoles, which in turn introduce third and higher order resonances. This effect sets an upper limit to the allowable beta-values in the high-beta quadrupoles of the interaction region. (auth)

**28946** EXTRAPOLATION OF THE ISABELLE DESIGN TO 400 x 400 GeV. Chasman, R. (Brookhaven National Lab., Upton, NY); Gluckstern, R. L. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1435-1438(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Consideration of a national program for the development of new high energy facilities during the next ten years suggests that the most appropriate energy for proton storage rings may be higher than the 200 x 200 GeV of the present ISABELLE design. It has been indicated that 300 x 300 GeV or 400 x 400 GeV may provide a more reasonable step to maximize the scientific potential of the next major proton storage ring facility. A preliminary analysis of the design consequences of changing the ISABELLE energy to 300 x 300 GeV and 400 x 400 GeV is given, keeping the luminosity, maximum field, and most of the original design parameters unchanged. It is concluded that the ISABELLE concept can be extrapolated to 400 x 400 GeV without any unmanageable technical

problems and that even higher energies seem to be feasible. (auth)

**28947** STATUS OF EPIC. Gray, D. A. (Rutherford Lab., Chilton, Eng.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1439-1442(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The status of EPIC, a proposed 14-GeV electron-positron storage ring which may be built at the Rutherford Laboratory, is given. Changes from the proposal are described, especially the characteristics of the booster injector and methods of beam bunching in the main ring. The R and D program on the components for the machine is also outlined. (auth)

**28948** EFFECTS OF BEAM–BEAM FORCES IN LARGE ELECTRON-POSITRON STORAGE RINGS. Rees, G. H.; Toner, W. T.; Trotman, J. V. (Rutherford Lab., Chilton, Eng.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1447-1450(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A symmetrical arrangement of sextupole magnets is included in the design of large electron-positron storage rings so as to provide low values of chromaticity. The strength of the sextupoles is such that they contribute appreciable non-linear effects. The maximum number of particles that can be brought into collision in the rings is then determined by the combined effects on particle motion of the sextupole fields and the beam-beam space charge forces. Approximate methods are described for estimating the response widths due to the combined action of the sextupoles and the beam-beam forces. In particular, the fourth-order terms due to the sextupoles are obtained, including both the resonance terms and those terms which give the variation of tune with amplitude. (auth)

**28949** SINGLE BEAM INSTABILITIES IN DORIS. Kohaupt, R. D. (Deutsches Elektronen-Synchrotron, Hamburg). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1456-1457(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In the electron- and positron rings of DORIS, strong transverse and longitudinal single beam instabilities caused current limitations. The most severe transverse and longitudinal instabilities were induced by excitation of higher modes in the rf-cavities. When these instabilities were cured by damping the higher cavity modes, the thresholds for these types of instabilities were greatly increased. The origin of the remaining transverse and longitudinal instabilities is not yet understood. The thresholds of these instabilities were increased by Landau-damping and by changing the betatron- and synchrotron frequencies from bunch to bunch. The head-tail effect was observed at high peak currents and was cured by compensating the chromaticity. In the electron ring, a transverse instability is induced by the ions. Ion clearing, in combination with some vacuum improvements, is sufficient to avoid this instability. (auth)

**28950** TRANSVERSE OSCILLATIONS DAMPING WITH WIDE-BAND FEEDBACK ON SPEAR II. Pellegrin, J. L. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1500-1504(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

With its high peak currents, SPEAR II is likely to show transverse coherent oscillations. A closed loop system, using the beams as a signal path, detects the bunch center-of-mass motion and reacts on the beams after one machine period with a set of traveling wave electrodes. The detector senses oscillations at the betatron frequency and rejects signals due to equilibrium orbit shifts. The amplifier output is solely determined by the desired gain and the detector noise. Since, for a given machine tune, the system phase margin can be made $90^0$ by selecting the respective location of the pickup and feedback electrodes, stability is secured for all values of gain. However, critical damping cannot be obtained except with infinite gain, and the system damping rate is strictly equal to the gain per turn. Measurements of the loop gain were carried out and agree with the observed damping. To date, the system was successful in dealing with injection oscillations and headtail instabilities. (auth)

**28951** VACUUM SYSTEM FOR THE STANFORD-LBL STORAGE RING (PEP). Bostic, D.; Cummings, U.; Dean, N.; Jeong, B.; Jurow, J. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1540-1543(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The vacuum system for PEP will be similar in design, construction, and operation to the system currently in operation at SPEAR. There will be quantitative differences since the closed path of PEP will be 10 times longer than the SPEAR path. Some qualitative differences will also arise since the radiated synchrotron power for PEP will be about 13 times greater than for SPEAR, giving rise to an increased linear power density incident on the chamber wall. Other differences arise from the higher energy spectrum of the synchrotron radiation. The SPEAR vacuum system has been in operation since April 1972 and has proven satisfactory in design, construction, and operation. The chamber was subject to synchrotron radiation for approximately 300 ampere-hours and the beam lifetimes are now more than several hours. The details of the PEP design and the SPEAR operating experience are discussed. (auth)

**28952** HIGH PRECISION SCRAPERS FOR ISR LUMINOSITY MEASUREMENTS. Potter, K.; Turner, S. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1589-1592(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Two intersections of the CERN ISR were recently equipped with beam scrapers. Controlled by computer, they permit the vertical profile of the circulating current intensity to be plotted automatically, so that the position of the center of a beam can then be determined to within 10 microns. This was used to calibrate the beam displacements used in the standard "Van der Meer" type luminosity measurements. The particle density profiles allow a direct evaluation of the luminosity. A description of the mechanism and the computer control system are given, and some results are discussed. (auth)

**28953** DESIGN AND PERFORMANCE OF THE STANFORD SYNCHROTRON RADIATION PROJECT (SSRP). Baer, A. D.; Gaxiola, R.; Golde, A.; Johnson, F.; Salsburg, B.; Winick, H.; Baldwin, M.; Dean, N.; Harris, J.; Hoyt, E.; Humphrey, B.; Jurow, J.; Melen, R.; Miljan, J.; Warren, G. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1794-1797(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The Stanford Synchrotron Radiation Project (SSRP) is now in full operation as a national facility utilizing the intense ultraviolet and x-radiation from the storage ring SPEAR at the Stanford Linear Accelerator Center (SLAC). The experimenter-operated facility is designed to maximize access to, and utilization of the radiation by 5 or more simultaneous users, within the limits of parasitic operation on a high energy colliding beam storage ring. A novel experimenter-controlled personnel protection system permits independent access to each of 5 experimental areas. A vacuum monitoring and control system protects the storage ring vacuum from contamination, rising pressure, or catastrophic failure. The design and operation characteristics of these control systems and of the beam position monitoring and control system, vacuum system, and thin beryllium windows are presented. (auth)

**28954** PURPOSE BUILT STORAGE RING FOR SYNCHROTRON RADIATION RESEARCH. (Daresbury Lab., England). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1817-1820(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Plans were approved for building a 2 GeV electron storage ring at the Daresbury Laboratory, specifically for producing beams of synchrotron radiation, and so provide a continuing research facility when the electron synchrotron, NINA, is phased out. The initial objective will be to achieve the maximum current obtainable (0.37 A) using a single 250 kW, 500 MHz klystron to provide the rf power. This will produce high fluxes of photons down to 1 A, initially along three beam lines feeding six experiments. User requirements have dominated the design considerations. Later developments proposed include the addition of a second klystron which will allow the beam current to be increased to 1 A and will also provide excess power to supply the additional requirements when special superconducting "wiggler" magnets are installed to extend the usable wavelength range down to 0.1 A. The number of beam lines is expected to increase to about ten. (auth)

**28955** CAN COHERENT UV RADIATION BE OBTAINED FROM EXISTING ELECTRON STORAGE RINGS. Schoenauer, H. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1821-1824(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Recently built electron storage rings provide very high transverse electron densities in their low-beta insertions. This suggests the feasibility of laser action of an electron storage ring at optical and even shorter wavelengths. Using a semiclassical theory of induced synchrotron radiation, it is shown that special bending devices should in fact allow for light amplification in this spectral range. The special bending unit should be an electrostatic deflector, providing an intense electric field by Coulomb type. Lower wavelength limits for laser action are estimated using reported or design performances of SPEAR I and DORIS. For the latter machine this limit is of the order of 3000 A, provided that an electric field strength of 10 kV/cm could be achieved and that the deflector is placed in a low-beta insertion. (auth)

**28956** BEAM ENERGY LOSS TO PARASITIC MODES IN SPEAR II. Allen, M. A.; Paterson, J. M.; Rees, J. R.; Wilson, P. B. (Stanford, Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1838-1842(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The energy loss due to the excitation of parasitic modes in the SPEAR II rf cavities and vacuum chamber components was measured by observing the shift in synchronous phase angle as a function of circulating beam current and accelerating cavity voltage. The resulting parasitic mode loss resistance is 5 M OMEGA at a bunch length of 6.5 cm. The loss resistance varies with bunch length sigma/sub z/ approximately as exp(-0.3 sigma/sub z/). If the measured result is compared with reasonable theoretical predictions, it may be inferred that the major portion of the parasitic loss takes place in ring vacuum components rather than in the rf cavities. (auth)

**28957** RF BEAM LOADING EFFECTS IN EPIC. Donald, M. H. R. (Rutherford Lab., Chilton, Eng.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1843-1846(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

In the proposed electron-positron storage ring EPIC, very high peak currents in the circulating beams will give rise to transient beam loading effects. These effects were studied in order to find the extra rf power needed because of them. (auth)

**28958** SOME IMPROVEMENTS OF CLOSED ORBIT CORRECTION METHODS APPLICATION TO DCI. Jejcic, A.; Chau, N. N. (Univ., Paris). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1866-1869(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

During DCI construction, the question of possible improvements in the usual methods of closed orbit correction was advanced. Some calculation techniques are presented, showing two advantages: (1) the perturbations and corrections are not treated as pointlike dipoles, but inserted in lattice computation by their exactly corresponding transfer matrices; and (2) the selection is not made among all possible correctors; a set of the statistically most efficient correctors is determined by computational simulation. (auth)

**28959** CONTROL OF CLOSED ORBIT DEVIATION DUE TO SYNCHROTRON RADIATION. Lee, M. J.; Morton, P. L.; Rees, J. R.; Richter, B. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1914-1915 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The energy loss by synchrotron radiation in electron-positron storage rings occurs in every bending magnet, and is thus distributed around the ring. The energy gain occurs at the rf cavities, which are usually lumped in only a few locations. This type of orbit distortion is usually negligibly small compared to the design allowance in existing synchrotrons and storage rings; however, in the case of the larger storage rings now being contemplated, the distortion can be substantial in comparison to beam size and is different for electrons and positrons. For studying this problem, the thin-lens lattice design program MAGIC was modified to compute the closed orbit distortion for any distribution of the rf system operating at any configuration. The computation of the closed orbit and the different options are discussed, and the reasoning used to decide on the solution of distributing the rf system for PEP is given. (auth)

**28960** NEW PROPOSED ACCELERATOR FACILITIES IN WESTERN EUROPE. Johnsen, K. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1941-1947(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

An account of the individually proposed high-energy facilities in Western Europe is given, without passing too much judgment on their coordination. The discussion is limited to major projects for elementary particle physics; a number of medium large projects are not included, such as the conversion of SATURNE to a nuclear structure facility and NINA to a synchrotron light facility, to mention two examples. (auth)

## Experimental Facilities

*Refer also to abstracts 28755 and 28760.*

**28961** (BNL-20476) DOSE AS A FUNCTION OF RADIAL DISTANCE FROM A 930 MeV $^4$He ION BEAM. Varma, M. N.; Paretzke, H.; Baum, J. W.; Lyman, J. T.; Howard, J. (Brookhaven National Lab., Upton, N.Y. (USA)). 15 Sep 1975. 26p. (CONF-750927-3). Dep. NTIS $4.50.

From 5th symposium on microdosimetry; Varbania Pallanza, Italy (22 Sep 1975).

A unique mesh wall ionization chamber (approximating a wall-less ionization chamber) was used to measure dose as a function of radial distance from a 930 MeV $^4$He ion beam in air. Measurements were made at distances from about 10 to 40 cm from the ion path. This represents simulated distances of approximately 102 to 404 mu m in tissue having a density of 1 g/cm$^3$. Experimental values are compared with theoretical calculations, and probable causes of differences found are discussed. (auth)

**28962** (ORNL-TM-4987) USE OF ORELA TO PRODUCE NEUTRONS FOR SCATTERING STUDIES ON CONDENSED MATTER. Peelle, R. W.; Lewis, T. A.; Mihalczo, J. T.; Mook, H. A.; Moon, R. M. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 67p. Dep. NTIS $5.45.

The Oak Ridge Electron Linear Accelerator (ORELA) is evaluated as a source of neutrons for condensed matter research. Two options are assessed: (1) use of the present target arrangement with minor modifications; and (2) the construction of a new target and experiment facility designed for condensed matter research and equipped with a subcritical fission booster. The expected source strength and time behavior are discussed, including the fundamentals of moderator design. The effect on the programs presently using the linac are considered. It is concluded that a special-purpose neutron source facility using pulsed electrons from ORELA and containing a subcritical booster could be built to make a cost-effective neutron scattering facility of great power and utility. (auth)

**28963** (ORNL-TM-5087) SAFETY ANALYSIS OF THE 2.5 MV ACCELERATOR IN THE SOLID STATE DIVISION'S POSITIVE HEAVY ION SCATTERING IMPLANTATION, CHANNELING AND SPUTTERING (PHISICS) FACILITY. Schow, O. E. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 19p. Dep. NTIS $4.00.

A safety system, with precautions against radiation hazards, electrical hazards, hazards from high pressure and high vacuum equipment, and fire hazards, is described. The possible radiation doses for operators are considered, including neutron production and ion implantation effects. The system logic and testing of the radiation monitor system are discussed, and a block diagram of the entire safety system is given. (PMA)

**28964** BATCH PROCESS FOR THE PRODUCTION OF $^{13}$N-LABELED NITROGEN GAS. Austin, S. M.; Galonsky, A.; Bortins, J. (Michigan State Univ., East Lansing (USA). Cyclotron Lab.); Wolk, C. P. (Michigan State Univ., East Lansing (USA). MSU; AEC Plant Research Lab.). Nucl. Instrum. Methods; 126: No. 3, 373-379(15 Jun 1975).

A technique was developed for generating $^{13}N^{14}N$ gas with specific activity 20 mCi/ml. The $^{13}$N is produced, nearly free of other radioactivities, in the $^{13}C(p,n)^{13}N$ reaction, using 17 mg amorphous carbon targets enriched to about 97 percent $^{13}$C and a proton bombarding energy of 11 MeV. The irradiated material is converted to $^{13}N^{14}N$ gas by automated Dumas combustion and compressed into 1 ml vials, the entire procedure taking less than 15 min. A number of biological tests showed that the $^{13}N^{14}N$ gas is essentially free of other labeled compounds of nitrogen. The advantages and disadvantages of other $^{13}$N-producing nuclear reactions are discussed. (auth)

**28965** LOW-VOLUME, HIGH PRESSURE GAS TARGET FOR USE IN ELECTRON-SCATTERING EXPERIMENTS. Crannell, H.; Finn, J. M.; Hallowell, P.; O'Brien, J. T. (Catholic Univ. of America, Washington, D. C. (USA). Dept. of Physics). Nucl. Instrum. Methods; 126: No. 3, 453-457(15 Jun 1975).

A thin-window, low-volume, high-pressure gas-target cell suitable for use in high-resolution electron-scattering investi-

gations is described. Details of the design and construction as well as the results of several tests are discussed. (auth)

**28966** NEW TYPE DEUTERIUM GAS TARGET. Bosman, M.; Jongen, Y.; Leleux, P.; Lipnik, P.; Macq, P.; Meulders, J. P.; Pirart, C.; Valenduc, G. (Louvain Univ. (Belgium)). Nucl. Instrum. Methods; 126: No. 3, 465-466(15 Jun 1975).

A low-background deuterium gas target for neutron production is described. A time-of-flight spectrum for the $^{2}H(d, n)^{3}He$ reaction at 50 MeV is presented as an example of operation of this target. (auth)

**28967** STUDY OF A HIGH-RESOLUTION SPECTROMETER WITH A $Cs^{+}$ ION BEAM. Kervizic, J.; Laune, B.; Tran, D. T. (CGR-MeV, Orsay, France). Nucl. Instrum. Methods; 126: No. 4, 573-577(1 Jul 1975).

An ionic adaptation of the method used by Foucault for light optics was used for high-resolution spectrometer studies. A low-energy $Cs^{+}$ beam is used to simulate a light-ion beam of higher energy. The apparatus, the method of pole-face correction, and the results of measurements on the spectrometer are discussed. (auth)

**28968** CHECKING THE ALIGNMENT OF A SCATTERING CHAMBER AND MEASURING ANGULAR RESOLUTION WITH THE AID OF A POSITION-SENSITIVE DETECTOR. Bovet, E.; Foroughi, F.; Pauletta, G.; Nussbaum, C. (Neuchatel Univ. (Switzerland). Inst. de Physique); Tchiguir, S. (Moskovskij Inzhenerno-Fizicheskij Inst. (USSR)). Nucl. Instrum. Methods; 126: No. 4, 587-588(1 Jul 1975).

A simple method for checking the alignment of a scattering chamber is proposed. The energy of the incident beam need not be known accurately, nor need its energy resolution be good. (auth)

**28969** BIG EUROPEAN BUBBLE CHAMBER AT CERN. I. Harigel, G. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Bl.; 31: No. 1, 13-28(Jan 1975). (In German).

The large bubble chamber installed at CERN is described. The expansion system, the refrigerating plant, the magnets with superconducting coils, the optics, and the evaluating apparatus for films are discussed in detail. (GE)

**28970** USES OF INTENSE ELECTRON BEAMS. Kolb, A. C. (Maxwell Labs., Inc., San Diego, CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 956-961(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Intense electron beams (power levels from $10^{11}$ to a few X $10^{12}$W, currents from 50 kA to megamperes, and electron energies from a few hundred keV to nearly 15 MeV) are being used in a broad range of new applications in many laboratories. The main applications include (1) flash x-ray generators; (2) controlled thermonuclear fusion (plasma heating and confinement, pellet fusion, and physics of high temperature, dense plasmas); (3) collective ion acceleration; (4) excitation of high-power lasers (noble gas excimer, transfer, and chemical lasers); and (5) microwave generators. Current research is reviewed, and high-power electron beam machine design is briefly discussed. (PMA)

**28971** PROBLEM OF WORK ON A HIGH ENERGY SYNCHROTRON SUBMITTED TO LARGE RADIATION DOSE. Gouiran, R. (CERN, Geneva). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1100-1103(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

Running a high energy synchrotron towards higher proton intensity causes a series of problems related to equipment damage and to work in radiation areas. Maintenance should therefore become an integral part of the organization, and some methods should be developed for evaluating and predicting irradiation of personnel and equipment. Effects of radiation on accelerator components, radiation and radioactivity measurements, and the dose received by the staff are discussed. (PMA)

**28972** STATUS OF THE CERN-KARLSRUHE SUPERCONDUCTING PARTICLE SEPARATOR. Bauer, W.; Citron, A.; Dammertz, G.; Grundner, M.; Husson, L.; Lengeler, H.; Rathgeber, E. (Kernforschungszentrums, Karlsruhe, Ger.). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1144-1147(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The present status of the rf separator is given, and measurements of single cavity sections and of two joined sections are reported. The problem of storing heat treated sections until final assembly was investigated. Flooding a cavity at room temperature with nitrogen deteriorates its performance, after the cavity was once excited to a peak electric field of 30 MV/m, corresponding to a peak magnetic field of 850 G and a deflecting field of 5.5 MV/m. This effect is assumed to be due to a sensitization of the surface oxides by field emission electrons. The effect is not observed after an electric field of up to 15 MV/m, and it also does not appear when the cavity is flooded with argon. (auth)

**28973** LIQUID DEUTERIUM NEUTRON ATTENUATOR FOR PROAD-BAND PHOTON BEAM FACILITY. Fast, R. W.; Otavka, M. A. (Fermi National Accelerator Lab., Batavia, IL). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1201-1203(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The photo-production facility at Fermilab uses a two section liquid deuterium attenuator, 103 feet in length, to reduce the neutron flux and produce a pure high energy photon beam. The facility is located in the Proton East experimental hall, and includes nine 10 foot long sweeping magnets. A unique refrigeration system supplies mechanically refrigerated helium gas trace cooling to condense deuterium directly in a flask. The control system permits remote operation of the cryogenic system and also acts as an interface to the Proton Area operations computer. The computer can be used to monitor the operating parameters and for partial control of the system. The facility is presently in use as part of the Proton Area experimental program. (auth)

**28974** HIGHLY STABILIZED POWER SUPPLY FOR SPECTROMETER. Gano, J. J. (Massachusetts Inst. of Tech., Middleton). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1229-1223(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The two 4000A, 150V power supplies for the spectrometer magnet of the Bates Linac have a current regulation and stability of better than .001 percent for an 8-hour period. Current sensing is accomplished by a 5-volt precision shunt. The output is programmed by a stable dc voltage reference with a 6-digit keyboard. The rate of current increase or decrease for controlling magnet excitation is adjustable up to a rate of 4000A per minute. Power dissipation in the 300 pass transistors of each supply is limited by automatically controlling the emitter to collector voltage with the use of a variable voltage transformer. To avoid possible conducted or radiated interference with experimental signals, no silicon-controlled rectifiers are used. The major portion of this article is devoted to an analysis of the stability. (auth)

**28975** Rf SEPARATORS AND SEPARATED BEAMS AT SLAC. Fieguth, T. H.; Gearhart, R. A. (Stanford Univ., CA). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1533-1536 (Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

For particle momenta above approximately 5 GeV/c, the only effective means of separation by particle mass in secondary beams is using rf deflectors. Particle separation at proton synchrotrons requires the use of two rf deflectors. The beam structure at SLAC permits the use of a single deflector. (auth)

**28976** USE OF MUONIC X-RAYS FOR TISSUE ANALYSIS. Reidy, J. J. (Univ. of Mississippi, University); Hutson, R. L.; Springer, K. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1780-1783(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The muonic x-ray spectrum resulting from negative muons stopping in tissue samples and tissue "equivalent" materials was obtained. Relative muonic x-ray intensities were determined, and an attempt was made to correlate these intensities with atomic abundances in these materials. A comparison of the results for the various targets is presented. Limits of sensitivity for fluorine and calcium in these biological materials was established. Results are outlined which demonstrate the feasibility of obtaining data in the singles mode, that is, without a muon telescope. This will allow the use of the higher muon beam intensities which will be available at LAMPF. In addition, the use of larger targets will be possible, and the possibility of using focusing collimators to interrogate a specimen is likely. (auth)

**28977** COMPARISON OF CONVENTIONAL L AND S-BAND ELECTRON LINACS AS PION SOURCES SUITABLE FOR RADIOTHERAPY. Haimson, J. (Haimson Research Corp., Burlington, MA); Mecklenburg, B.; Williamson, C. IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1805-1808(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

A discussion on target configuration and negative pion yield, supported by high power electron beam experimental data, estab-

lishes 250-330 kW at 500 MeV to be desirable beam parameters for an electron linac. In combination with a Stanford carrousel type pion spectrometer, a linac with these beam conditions would provide a practical source of $\pi^-$ mesons suitable for radiotherapy applications. A preliminary analysis confirms that peak current limitations imposed by cumulative beam breakup may be avoided by adopting specific microwave design procedures. These procedures should minimize higher order mode transverse shunt impedances in potentially troublesome zones of individual waveguides and should introduce higher order mode stop bands at specific locations along the beam centerline, similar to the techniques used for the MIT and IKO high duty factor linacs. (auth)

**28978** DESIGN OF AN INTENSE FAST NEUTRON SOURCE. Hepburn, J. D.; Ormrod, J. H.; Chidley, B. G. (Chalk River Nuclear Labs., Ontario). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 3, 1809-1812(Jun 1975).

From particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975). See CONF-750335-.

The design of a $4 \times 10^{12}$ $s^{-1}$ source of 14 MeV neutrons is described. The neutrons are produced by the $T(d,n)^4He$ reaction using a 25 mA, 300 keV beam of atomic deuterons bombarding a water-cooled, rotating drum-shaped titanium-tritide target. The drum dimensions are chosen to give at least a 100-hour half-life for the neutron source strength. (auth)

# PHYSICS (ASTROPHYSICS AND COSMOLOGY)

**28979** SEVENTH SPACE CONGRESS, TECHNOLOGY TODAY AND TOMORROW, COCOA BEACH, FLORIDA, APRIL 22–24, 1970. Volume I. Cape Canaveral, FL; Canaveral Council of Technical Societies (1970). vp. (CONF-700460--).

Papers were presented on the following topics: future mechanical space vehicle systems, earth resources satellites application, advanced techniques in education, engineering applications in medicine, future electronic/electrical space vehicle systems, oceanographic projects, manufacturing processes in space, developments in astronomy, viewpoints on systems engineering, land transportation systems, meteorological projects, and future applications of electronics. Individual abstracts are given for one paper. (BJG)

*For abstract of individual paper see: 29082.*

**28980** DER NEUE KOSMOS. (New Cosmos). Unsoeld, A. Berlin; Springer-Verlag (1974). 450p.

The book gives an introduction into today's astronomy and astrophysics. The most important observations, where possible, are treated together with basic theoretical statements. Moon landings, planet probes, continent displacement etc.; pulsating radiosources, X-ray and $\gamma$-sources; interstellar molecules; quasars; formation and development of stars and galaxies up to the cosmologic world models etc. are included in the extended 2nd edition. (GE)

**28981** M4 THE CLOSEST GLOBULAR CLUSTER. Alcaino, G. (European Southern Observatory, Santiago de Chile). Astron. Astrophys., Suppl. Ser.; 21: No. 1, 5-14(Jul 1975).

A BV photometric investigation of the bright Southern Globular Cluster M4 was carried out using the 1m telescope of Cerro Las Campanas (CARSO). Seventeen stars were observed photoelectrically; the limiting magnitude is V = 15.80. Using this sequence 531 stars were measured photographically. The apparent distance modulus from the mean visual magnitude of 30 horizontal branch RR Lyrae stars within a radius of 9.3 from the cluster centre and adopting $M_v = +0.6$ for their absolute magnitude is (m–M) app. = 12.86. The adopted distance is 1.75 kpc making it the closest globular cluster to the sun, highly reddened by E(B-V) = $0^m.55$ because of the dark nebulosity in Scorpio-Ophiuchus. The giant branch rises $2^m.45$ above the horizontal branch at $(B-V)_0 = 1^m.4$, characteristic of an object of medium metallicity. (auth)

**28982** ASTRONOMICAL SOCIETY OF AUSTRALIA, PROCEEDINGS OF EIGHTH ANNUAL GENERAL MEETING, HOBART, AUSTRALIA, May 22–24, 1974. Vol. II. Hobart, Australia; Astronomical Society of Australia (1974). 86p.

Applications of model atmospheres are considered along with the Jupiter radio bursts, the inverted alt-alt configuration for optical telescopes, the motions of formaldehyde clouds near Sgr A, thioformaldehyde clouds in the direction of Sgr B2, and the positions of associated type II and type III solar radio bursts. Other topics discussed are related to supersonic turbulent stress and the solar neutrino flux, the temperature structure of a stellar atmosphere heated by soft X rays, the dwarf nova EX Hydrae, and a flexible fast-photometry system. (IAA)

**28983** SOME PROBLEMS AND PROSPECTS FOR NUCLEAR ASTROPHYSICS. Kocharov, G. E. pp 147-182 of Problems in Modern Physics. Leningrad; Izdatel'stvo Nauka (1974). (In Russian)

Some results of theoretical investigations into the problems of thermonuclear reactions in the solar interior, solar neutrinos, and the interaction of superhigh-energy cosmic rays with the neutrino sea in the universe and with the relic background of phonons are discussed. Some experimental studies of astrophysical phenomena connected with variations in the radiocarbon concentration in trees are also discussed, in particular, such phenomena as supernova outbursts, solar activity, and variations of the earth's magnetic field. Results of studies concerning corpuscular fluxes in space and in the lunar soil carried out by instruments on Lunokhod vehicles are discussed. (IAA)

## Cosmic Radiation

*Refer also to abstracts 28061, 28983, 29090, 29112, 29129, and 29353.*

**28984** (KFKI-75-47) SECOND SPHERICAL HARMONICS OF THE COSMIC RAY ANGULAR DISTRIBUTION. Kota, J. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). 1975. 11p. (CONF-750805-10). Dep. NTIS (US Sales Only) $4.00.

From 14th international cosmic ray conference; Munich, F. R. Germany (15 Aug 1975).

The second spherical harmonics of the three dimensional cosmic ray angular distribution are deduced from the statistical Boltzmann equation. The density gradient and pitch angle distribution models are discussed. It is suggested that the semidiurnal variation is produced, in an indirect way, by the 0.3 per cent sunward streaming observed by Dyer et al in the 1 + 5 GV range. (auth)

**28985** SOLAR AND GALACTIC COSMIC-RAY ACTIVATION OF LUNAR SAMPLES. Eldridge, J. S. (Holifield National Lab., Oak Ridge, TN); O'Kelley, G. D.; Schonfeld, E. Trans. Am. Nucl. Soc., Suppl.; 21: No. 3, 10(1975).

From international nuclear and atomic activation analysis conference and 19th annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

**28986** ULTRAHEAVY COSMIC RAYS. Israel, M. H. (Washington Univ., St. Louis); Price, P. B.; Waddington, C. J. Phys. Today; 28: No. 5, 23-31(May 1975).

The discussion of ultraheavy cosmic rays covers their discovery, the astrophysical significance, the source region, synthesis of the nuclei, theoretical predictions, experimental results, research at Skylab, and the future direction of the research. (JFP)

**28987** EAS SPACE DISTRIBUTION AT LARGE HEIGHTS. Kalmykov, N. N.; Khristiansen, G. B. (Moscow State Univ.). Yadern. Fiz.; 21: No. 4, 757-762(Apr 1975). (In Russian).

The effect of the transverse momentum of pions on the space distribution function of the EAS electrons at the depth of 200 g/cm$^2$ is studied. It is shown that taking into account the transverse momentum results in a considerable growth of the parameter S near the axis of the shower, decreases the part of the total number of particles that occupies the central region of EAS, increases the density fluctuation and produces new false axes. Troubles arising due to detection of EAS by set-ups of small dimensions are analysed. (1 table, 4 figures) (auth)

**28988** UNDERGROUND MUONIC GROUPS. Kel'ner, S. R.; Kotov, Yu. D.; Logunov, V. M. (Moscow Engineering–Physics Inst.). Yadern. Fiz.; 21: No. 4, 763-771(Apr 1975). (In Russian).

The characteristics of muonic groups generated by cosmic muons via direct pair production in the Coulomb field of a nucleus are studied. The EAS muonic groups are considered. The experimental data on the undergound muonic groups are compared with theoretical predictions. The analysis shows that the existing data on muonic groups give no evidence for any other mechanism of generation of groups which yields the cross sections comparable with those of the present paper. (2 tables, 5 figures) (auth)

**28989** HIGH TRANSVERSE MOMENTUM SECONDARIES IN COSMIC RAY INTERACTIONS UP TO $10^7$ GeV. Halzen, F. (Wisconsin Univ., Madison (USA). Dept. of Physics). Nucl. Phys., B; 92: No. 3, 404-412(7 Jul 1975).

Recent observation of secondary $\pi^0$'s from cosmic ray interactions with primary energy (E) between $10^4$ and $10^7$ GeV confirm the recent discovery in FNAL and CERN ISR experiments of a component of the proton-proton interaction, growing with energy, yielding an unexpected number of high transverse momentum ($p_T$) secondaries. That the underlying dynamics is very different from the component of hadron interactions yielding the bulk of small $p_T$ pions is confirmed by cosmic ray experiments in the observed invariant mass, multiplicity, and most strikingly in the $p_T$ distribution of the secondaries. Furthermore, a comparison of the measurements with accelerator data supports the validity up to $10^7$ GeV of scaling laws in the variable $x_T = 2p_T/\sqrt{s}$ ($\sqrt{s} \simeq 2mE$) suggested by constituent models of hadrons. Further tests of these models, accessible with the existing low statistics, but extremely high-energy cosmic ray data, are discussed, e.g. the multiple core or jet structure of the produced $\pi^0$'s. (auth)

**28990** DO EXTENSIVE AIR SHOWER DATA PROVIDE RELIABLE INFORMATION ON THE PROTON–PROTON TOTAL CROSS SECTIONS. Formanek, J.; Franek, B. (Science Research Council, Chilton (UK). Rutherford Lab.). Nucl. Phys., B; 92: No. 3, 427-444(7 Jul 1975).

The zenith angle dependence of frequencies of extensive air showers is discussed from the point of view of nucleon–nucleon total cross sections. It is shown that this kind of data cannot (without additional assumptions) distinguish between asymptotically constant cross sections and those increasing as ln s or even as $(\ln s)^2$. (auth)

**28991** ABSOLUTE VERTICAL MUONIC INTENSITY ON SEA LEVEL AT 1 GeV/c. Jokisch, H. Kiel; Univ. Kiel (1973). 68p. (In German). INIS.

Thesis.

The absolute differential and integral muonic intensity at 1 GeV/c was measured vertically at sea level with the aid of a range spectrometer. The spectrometer has a product of solid angle and area of 1.13 $cm^2sr$ and consists of two lead absorbers of a thickness of 60 cm and 15 cm (anticoincidence method) and 5 scintillation counters. The measured rates were corrected with regard to inefficiency of the apparatus, cosmic-ray showers, multiple scattering, muon straggling and variations of intensity (caused by atmospheric effects and solar influences). The findings of this paper as well as recent measurements of other authors show that the value of 1 GeV/c (ROSSI point) which has up to now been used as normalization point for muon spectra should be raised by 25%. (GE)

**28992** DUST MODEL FOR THE COSMIC MICROWAVE BACKGROUND. Wickramasinghe, N. C.; Edmunds, M. G. (University Coll. of South Wales and Monmouthshire, Cardiff (UK)); Chitre, S. M.; Narlikar, J. V.; Ramadurai, S. (Tata Inst. of Fundamental Research, Bombay (India)). Astrophys. Space Sci.; 35: No. 1, L9-L13(Jun 1975).

The cosmic microwave background may be explained on the basis of absorption and re-emission of the light from galaxies by graphite whiskers of lengths $1 \approx 0.1$-1 mm. The mass density of such particles required is of the order of $10^{-34}$g $cm^{-3}$. (auth)

**28993** FLUX OF COSMIC RAY HEAVY NUCLEI ENDERS BEHIND LOW SHIELDING. Allkofer, O. C. (CERN, Geneva); Heinrich, W. J. Spacecr. Rockets; 12: No. 2, 119-121(Feb 1975).

The attenuation of the flux of heavy nuclei in the atmosphere is measured and the fragmentation probabilities deduced from these results. Energy spectra of different charge groups of nuclei in absorber depths of 0 to 40 $gcm^{-2}$ are calculated from the primary spectra. The number of stopping nuclei per $cm^3$ tissue sterad and hour as a function of the thickness x $gcm^{-2}$ of the penetrated matter is deduced and expressed in the form of an exponential law. A comparison is made between calculated and experimental flux measurements. Absorption curves are calculated. (BJG)

**28994** INFLUENCE OF NONGRAVITATIONAL EFFECTS ON THE EVOLUTION OF DUST PARTICLES IN NEAR-SOLAR SPACE. Dobrovol'skii, O. V.; Egibekov, P. E. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 18: No. 1, 16-19(1975). (In Russian).

A formula is presented that indicates the decrease in relative size of dust particles with relative orbital eccentricity. The calculations show that meteorites from the South Taurides, Capricorn, and Andromeda are rapidly reduced in size, and do not last long in the solar system, but are selectively removed from orbit. Radiation from the sun directly interacts with the surface of the dust particles by evaporation and sputtering, and carries away part of the matter from the surface of the particle. (SJR)

**28995** COSMIC RAYS GUIDED BY A MAGNETIC FIELD: THE SOURCE OF QUASAR EMISSION LINES. Stoner, R. E.; Ptak, R. L. (Bowling Green State Univ., Ohio (USA). Dept. of Physics). Astron. Astrophys.; 35: No. 2, 191-195(Oct 1974).

6 figs.; 1 tab.; 10 refs.

The broad emission lines observed in quasars and in the nuclei of Seyfert galaxies can be produced by way of atomic collision processes, with the characteristic velocities for the atomic events corresponding to the observed Doppler broadening. A model is proposed in which suprathermal particles, guided by a magnetic field and diffusing in pitch angle, interact with a stationary gas to produce the broad emission lines. Profiles predicted by the model are in good agreement with observed emission lines in high redshift quasars and Seyfert galaxy nuclei. (auth)

**28996** GALACTIC $\gamma$-RAYS AND COSMIC RAY ORIGIN. Dodds, D.; Strong, A. W.; Wolfendale, A. W. (Univ. of Durham, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 569-577(Jun 1975).

Gamma-ray emission from the Galaxy in directions away from the Galactic Centre supplies a test for models for the origin of cosmic ray nuclei of a few GeV. Extragalactic origin is shown to be improbable, while a plausible distribution of Galactic sources gives a good explanation of the observations. (auth)

**28997** DECELERATION EFFECTS OF SOLAR WIND IN COSMIC RAY VARIATIONS. Salimzibarov, R. B. (Inst of Cosmophysics Research and Aeronomy, Moscow). pp 335-340 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Description of a mechanism for solar-wind deceleration as a participating factor in cosmic-ray intensity variations. The mechanism is based on certain statistical aspects of charged particle acceleration in a turbulent plasma, and it involves the interaction of cosmic rays with Langmuir plasmons in turbulent interplanetary plasma. (IAA)

**28998** ZONAL HARMONIC COMPONENTS OF COSMIC RAYS IN INTERPLANETARY SPACE. Takahashi, H. (Iwate Univ., Morioka, Japan); Nagashima, K. pp 341-347 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A formulation to calculate zonal harmonic components of cosmic rays in interplanetary space and the detailed method to analyze cosmic ray data from network of cosmic ray stations for obtaining the harmonic components by using the formulation are presented. Some examples of the analysis are also given and discussed. (auth)

**28999** QUIET-TIME AND FLARE-TIME VARIATIONS IN THE COSMIC RAY TRANSPORT PATH. Gorchakov, E. V.; Timofeev, G. A.; Morosova, T. I. pp 297-306 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The data on anisotropy of protons and other charged particles are used to analyze the state of interplanetary medium. The state of the medium was preset by transport scattering path. The entire aggregate of experimental data for the 1-5 MeV and 5-10 MeV protons obtained in the Soviet Union from the Venus and Mars series of space probes are considered. Conclusions are drawn about the transport path variability in time and dependence on solar activity level and particle energies. (auth)

**29000** NEW CONCEPT OF THE DAILY VARIATION OF COSMIC RADIATION BASED ON DIFFUSION AND CONVECTION. Rao, U. R.; Agrawal, S. P.; Ananth, A. G. (Physical Research Lab., Ahmedabad, India). pp 313-317 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Results obtained from the anisotropy of solar cosmic radiation have been extended to evolve a new picture of cosmic-ray daily variation based on simple convection and diffuison. It has been shown that the cosmic-ray daily variation, both on average and also on a day-to-day basis, agrees with this simple picture. By estimating the convection vector from the observed solar-wind velocity and comparing it with the interplanetary magnetic-field measurements, both derived from observations on various spacecraft, it has been shown that, on average, the transverse diffusion is negligible on approximately 80 per cent of the days. On the rest of the days, the transverse diffusion seems to add a significant component to the cosmic-ray variation in the interplanetary medium. Such days are often characterized by an early morning maximum and are accompanied by abrupt changes in the interplanetary magnetic-field vector having a scale size of the order of 5 to 6 hours. (auth)

**29001** MODULATION OF COSMIC RAY INTENSITY UNDERGROUND ASSOCIATED WITH THE PLANET JUPITER. Jacklyn, R. M. (Tasmania Univ., Hobart, Australia); Cin-Castagnoli, G. pp 318-326 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Pressure corrected bi-hourly values of underground meson intensity were analyzed from records maintained by the University of Tasmania underground facility over a 12-year period between January 1958 and December 1969. The results indicate that a minimum of intensity occurs at about the time that Jupiter transits the meridian. This observation could be interpreted either that Jupiter is directly responsible for depression of intensity when it crosses the viewing cone of the underground detector or that Jupiter is indirectly responsible by modulation of the sidereal diurnal intensity variation. The probabilities of these two hypotheses are considered, and the experiments required for unequivocal decision are discussed. (IAA)

**29002** PARTICLE TRACK RECORD IN LUNAR SILICATES: LONG-TERM BEHAVIOR OF SOLAR AND GALACTIC VH NUCLEI AND LUNAR SURFACE DYNAMICS. Yuhas, D. E. Seattle;

Washington Univ. (1974). 282p. University Microfilms Order No. 75-6627.

Thesis (Ph. D.).

Stored nuclear particle tracks are abundant in all major mineral phases found on the moon. The track production in the near surface regions (depth less than 1 mm) is dominated by VH (Z greater than 20) cosmic rays of solar origin. At deeper depths (greater than 5 mm) heavy galactic cosmic rays dominate the production. The track profile (track density vs depth) is shaped by both the energy spectrum of impinging VH nuclei and dynamical processes which change rock surfaces with time. The analyses of track records in a number of lunar rocks with different surface exposure histories yield information about both dynamical processes on the moon and the long-term time behavior of solar and galactic cosmic rays. (Diss. Abstr. Int., B)

**29003** QUASI-PERIODIC COSMIC RAY VARIATIONS. Alaniia, M. V.; Shatashvili, L. Kh. Tiflis, USSR; Izdatel'stvo Metsniereba (1974). 138p. (In Russian).

Experimental data on cosmic ray intensity variations obtained at the Georgian Institute of Geophysics are analyzed and generalized. The topics discussed are: mathematical methods for the evaluation of cosmic ray intensity (including the effect of the cosmic ray neutron component), characterization of interplanetary space and studies of the 27-day variations of the cosmic rays, and solar-diurnal anisotropy of cosmic rays and its variations with the rotating sun. The 27-day cosmic ray modulation due to the asymmetric solar wind is examined, and the results obtained are discussed. Determination of the interplanetary magnetic field direction and the second harmonic of diurnal cosmic ray variations are considered. The 27-day variations of the anisotropy of the cosmic ray neutron component for the entire IGY are plotted and analyzed. Undergound facilities used in the investigations are described. (IAA)

**29004** INVESTIGATION OF CORPUSCULAR RADIATION ON SATELLITES AND SPACE VEHICLES. Kolchin, A. A.; Lebedev, V. V.; Skrebtsov, G. P. pp 231-244 of Problems in Modern Physics. Leningrad; Izdatel'stvo Nauka (1974). (In Russian)

Some of the corpuscular radiation experiments carried out on the Kosmos-135 and Kosmos-136 satellites and on the Zond-4 and Zond-5 spacecraft are described. A "sandwich" counter was used in a search for antiions from cometary matter with annihilation processes serving as a point of departure. Although the anomalous counting rate data obtained during the periods of Ursids and Geminids activity may be explained by the hypothesis of the antimatter nature of the meteor streams, the evidence for this is not unequivocal. Also reported are a study of the spectrum and composition of the nuclear component of primary cosmic rays and some observations of low-energy solar protons. (auth)

**29005** SOME STUDIES OF THE MULTIPLY CHARGED COMPONENT OF COSMIC RAYS CARRIED OUT IN SATELLITES AND AUTOMATIC SPACE PROBES. Ivanova, N. S. pp 245-264 of Problems in Modern Physics. Leningrad; Izdatel'stvo Nauka (1974). (In Russian)

The present work summarizes and evaluates some of the principal results obtained from the development of photoemulsions exposed at 300 km altitude on the Kosmos-4, Kosmos-213, and Soyuz-5 satellites and outside the earth's magnetic field on the Zond-5 and Zond-7 space probes. Data permitted some calculations to be made on an upper limit for the antinucleon content in cosmic rays. Estimates were made on the flux of nuclei of the Fe group and on the abundance of nuclei with Z greater than 24 relative to the abundance of the Fe group. Data were also obtained on the fragmentation of the multiply charged component of cosmic rays and on the interaction of relativistic nuclei with nuclei at small impact parameters. (IAA)

**29006** SEARCH FOR ANTIPROTONS IN THE PRIMARY COSMIC RADIATION. Romanov, V. A. pp 265-276 of Problems in Modern Physics. Leningrad; Izdatel'stvo Nauka (1974). (In Russian)

Results of studies of the east-west asymmetry displayed by primary cosmic radiation particles are critically examined. Refinements in the technique for measuring the azimuthal asymmetry of primary cosmic radiation are discussed. The application of a magnetic spectrometer for the measurement of antiproton flux is described. (IAA)

**29007** DIFFUSE X-RAY SPECTRUM FROM 10 TO 40 keV MEASURED WITH ROCKET-BORNE SCINTILLATION COUNTERS. Ikeda, M. (Nagoya Univ. (Japan). Dept. of Physics). Astrophys. Space Sci.; 35: No. 2, 255-268(Jun 1975).

The energy spectrum of the diffuse component of cosmic x-rays was measured with rocket-borne scintillation counters. Subtracting the environmental background unambiguously by means of the shutter method, the absolute values of the cosmic x-ray flux are obtained in a few keV band from 10 to 40 keV. The result indicates that the energy spectrum sharply changes its slope around 20-30 keV. Some trial functions for the spectrum are compared with the result; among them a thermal bremsstrahlung spectrum and a two-slope power law spectrum seem to fit very well. The former needs, however, another origin of x-rays in the lower and higher energy regions. "Sharpness" of the break in the case of the latter is discussed, including a data point in high energy side from a balloon experiment. The acceptable range of the spectral index in the high energy side is 2.3-2.6, that of the break energy is 20-30 keV and the corresponding transition width is smaller than 50 keV, if the confidence level is to be better than 5%. Non-thermal x-ray generation due to the inverse Compton effect does not reproduce the x-ray spectrum, even if the electron spectrum shows a sharp break. Bremsstrahlung with the non-thermal electrons or protons with a sharp cut in the low energy side of the spectrum can reproduce the result, though such a cut seems unrealistic. The result may suggest that current theories on the origin of the diffuse x-rays have to be revised. (auth)

## Stars

*Refer also to abstracts 27642, 28982, 28983, 29092, 29153, 29156, 29173, and 29287.*

**29008** (LA-UR-75-1625) CEPHEID PULSATION THEORY AND MULTIPERIODIC CEPHEID VARIABLES. Cox, A. N.; Cox, J. P. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-ENG-36. 21p. (CONF-750940-1). Dep. NTIS $4.25.

From 29th colloquium of the I.A.U. multiple periodic variable stars; Budapest, Hungary (1 Sep 1975).

In this review of the multiperiodic Cepheid variables, the subject matter is divided into four parts. The first discusses general causes of pulsation of Cepheids and other variable stars, and their locations on the H-R diagram. In the second section, the linear adiabatic and nonadiabatic theory calculation of radial pulsation periods and their application to the problem of masses and double-mode Cepheids are reviewed. Periodic solutions, and their stability, of the nonlinear radial pulsation equations for Cepheids and RR Lyrae stars are considered in the third section. The last section provides the latest results on nonlinear, nonperiodic, radial pulsations for Cepheids and RR Lyrae stars. (BJG)

**29009** (UCRL-76961) MAGNETOHYDRODYNAMICS NEAR A BLACK HOLE. Wilson, J. R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Aug 1975. 33p. (CONF-750734-1). Dep. NTIS $4.75.

From meeting on the recent progress of the fundamentals of general relativity miramare; Trieste, Italy (7 Jul 1975).

A numerical computer study of hydromagnetic flow near a black hole is presented. First, the equations of motion are developed to a form suitable for numerical computations. Second, the results of calculations describing the magnetic torques exerted by a rotating black hole on a surrounding magnetic plasma and the electric charge that is induced on the surface of the black hole are presented. (auth)

**29010** BINARY X-RAY SOURCES. Giacconi, R. (Harvard Coll. Observatory, Cambridge, Mass. (USA)). pp 147-180 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands: Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

The observational data concerning binary X-ray sources is reviewed, with emphasis placed on Her X-1, Cen X-3 and Cyg X-1. In particular, the evidence for the identification of Cyg X-1 as a black hole is discussed. (auth)

**29011** ACCRETION ONTO RELATIVISTIC OBJECTS. Rees, M. J. (Sussex Univ., Brighton (UK)). pp 194-212 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

The physics of spherically symmetrical accretion onto a compact object is briefly reviewed. Neither neutron stars nor stellar-mass black holes are likely to be readily detectable if they are isolated and accreting from the interstellar medium. Supermassive black holes in intergalactic space may however be detectable. The effects of accretion onto compact objects in binary systems are then discussed, with reference to the phenomena observed in variable X-ray sources. (auth)

**29012** LOWER BOUND ON NEUTRINO PAIR EMISSION. Mikaelian, K. O. (Pennsylvania State Univ., University Park (USA). Dept. of Physics). Phys. Lett., B; 57: No. 2, 181-182 (23 Jun 1975).

Weak neutral currents affect the rates with which stars lose energy by emitting neutrino pairs. These rates can be calculated once the parameters of the underlying theory are fixed. Here it is shown that any new gauge theory will have a minimum rate, equal to half the old rate. The proof rests on the (assumed) $\mu$-e universality of neutral currents. The possible existence of new types of neutrinos which may considerably enhance stellar cooling is also speculated on. The minimum becomes $((n+1)/(n+2))$ times the old rate, where n = number of new neutrinos. (auth)

**29013** ABNORMAL STATE OF PURE NEUTRON MATTER: EFFECTS OF CORRELATIONS. Kaellman, C. G. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)); Moszkowski, S. A. (California Univ., Los Angeles (USA)). Phys. Lett., B; 57: No. 2, 183-185(23 Jun 1975).

It is shown that two different quasi classical approaches to abnormal states of dense nucleons give binding in pure neutron matter. Effects of short range correlations are found to increase the critical density. (auth)

**29014** PAIR PRODUCTION FROM HOT PLASMA IN THE PRESENCE OF A STRONG MAGNETIC FIELD. El-Khishen, M.; El-Gowhari, A. (Cairo Univ.). Acta Phys. Acad. Sci. Hung.; 38: No. 1, 19-26(1975).

Radiation loss due to pair production by an intense electromagnetic wave is calculated. The calculations were made in the coulomb field of the ions and in the presence of a constant strong magnetic field aligned along the z-direction. The expression obtained for the radiation loss can be used for the case of nonrelativistic electrons and positrons. These calculations may be of great importance for the astrophysical estimations, since the basic mechanism of the energetic losses is mainly due to pair production. (auth)

**29015** MODEL FOR GAMMA EMISSION FROM THERMAL X SOURCES. Serio, S. (Univ., Palermo, Italy). Nuovo Cim., B; 28B: No. 1, 143-151(11 Jul 1975).

The cocoon model for x-ray sources is examined. It is shown that inverse Compton scattering of relativistic electrons which are emitted from the central pulsar causes an appreciable flux of gamma radiation emitted in the MeV range. The same electrons give by collisions with the plasma, the energy necessary to maintain the x-ray flux. The ratio of x to gamma luminosity, dependent only on the shape of the electron spectrum, is computed for both power law and monochromatic spectra. The results are consistent with the gamma observations from the Cygnus region. (auth)

**29016** STATISTICAL ANALYSIS OF R CrB, RY Sgr, AND SU Tau BRIGHTNESS. Koval'chuk, G. U.; Lenderman, E. I.; Lukatskaya, F. I.; Rozenbush, A. E. (Astronomical Observatory, Kiev). Astrometriya Astrofiz.; No. 25, 3-9(1975). (In Russian).

The autocorrelative functions and distribution functions of brightness are obtained for R CrB, RY Sgr and SU Tau, using sequences of visual observations. The distributions of time intervals between the consequent V magnitudes are also calculated. The brightness gradients are obtained using UBV observations during minima. (13 refs, 9 figs, 1 table) (auth)

**29017** GRAVITATIONAL CONTRACTION OF PROSTARS. III. Heavy Elements Role in the Evolution of Protostars. Kolesnik, I. G. (Astronomical Observatory, Kiev). Astrometriya Astrofiz.; No. 25, 10-19(1975). (In Russian).

The regularities of gravitational contraction of a protostar with a solar mass and volume energy losses due to neutral atoms of carbon and oxygen were considered. It is shown that after the phase of quasi-free contraction a core formation takes place, where the pressure forces are essential. A shock wave arises around the core. Pulsational relaxation accompanies the transition to the contraction under the control of pressure forces. The effect of finite optical depth of heavy elements lines on volume energy losses and possibility of development of the calculated properties in evolution of interstellar clouds are discussed. (7 refs, 8 figs) (auth)

**29018** MODEL STELLAR LATE-TYPE ATMOSPHERES. II. Sources of Opacity. Panchuk, V. E. (Odessa State Univ.). Astrometriya Astrofiz.; No. 25, 20-26(1975). (In Russian).

The results of calculations of opacity in the atmospheres of cool stars are discussed. (18 refs, 7 figs) (auth)

**29019** ANALYSIS OF THEORETICAL VALUES OF LINEAR LIMB DARKENING COEFFICIENTS OF THE DWARF STARS OBTAINED FROM THEIR MODEL ATMOSPHERES. Rubashevskii, A. A. (Kiev Planetarium). Astrometriya Astrofiz.; No. 25, 27-38(1975). (In Russian).

On the basis of calculations and tabular comparisons, the differences in theoretical coefficients of limb darkening connected with both the methods of their determination and properties of the models themselves are discussed. Dependence of the darkening coefficients on wavelength, temperature, log g and parameters of chemical composition is considered for a set of model atmospheres. It is shown that in some cases the effect of differences in the models on the darkening coefficient value is so large that it permits the best model to be chosen by solving the light curves of corresponding eclipsing systems. For stars KO-O8 in the region of 3646 Å-8205 Å the darkening coefficients are calculated under condition of conserving the constant radiation flux of the star. (24 refs, 6 tables) (auth)

**29020** STATIC CYLINDER OF PERFECT FLUID WITH NON-ZERO SPIN DENSITY. Prasanna, A. R. (Kernphysik der Univ., Bonn). Phys. Rev., D; 11: No. 8, 2083-2087(15 Apr 1975).

The interior field of an infinite static cylinder of a perfect fluid having the spins of the individual particles aligned along the axis of symmetry was studied. A solution was obtained with an assumed equation of state, and the pressure and the density were expressed as departures from their values on the symmetry axis. As in the case of spherical symmetry, the pressure is discontinuous across the boundary of the cylinder. (auth)

**29021** EVIDENCE AGAINST SOLIDIFICATION OF A MODEL NEUTRON SYSTEM. Clark, J. W.; Sandler, D. G. (Washington Univ., St. Louis). Phys. Rev., D; 11: No. 12, 3365-3369(15 Jun 1975).

It is argued, on the basis of recent ideas of Feenberg on the representation of the wave function of a solid together with the accurate equation-of-state data calculated by Shen, Sim, and Woo, that a system of Boltzmann neutrons interacting via the soft repulsive core of the Reid $^1S_0$ potential fails to crystallize at densities relevant to neutron stars. (auth)

**29022** ZERO-POPULATION STARS. Castellani, V. (Rome Univ. (Italy). Instituto di Fisica); Paolicchi, P. (Osservatorio Astronomico di Milano-Merate, Italy). Astrophys. Space Sci.; 35: No. 1, 185-196(Jun 1975).

The expected characteristics of stars with zero metal content are investigated for a large range of masses and in varying the original helium-content. It is shown that, in such an extreme case (Z = 0), the Main Sequence locus is much less sensitive than expected to the He-content; Y = 0 models are found to ignite $3\alpha$ reactions in the Zero-Age Main Sequence at masses larger by $\sim 5\ M_\odot$ than in the Y = 0.2 case. A comparison with previous results discloses the M.S. slope to be a sensitive function of the metal content only. Evolutionary computations confirm that possible survivors of the zero population can develop a giant branch, akin to that of the well-known Population II stars. (auth)

**29023** ACCELERATION OF ISOLATED ATOMS BY RADIATION PRESSURE. Gordon, R. H. (California Univ., Berkeley (USA). Dept. of Physics). Astrophys. Space Sci.; 35: No. 1, 197-202(Jun 1975).

If isolated atoms are accelerated by a point source of radiation with a power law spectrum and an intensity sufficiently large that radiation pressure dominates other forces, and if both acceleration and photoionization of the ions are considered, the resulting spectrum of escape velocities is independent of the intensity of the radiation, depending only on the power law index. For power-law indices typical of astrophysical objects, relativistic velocities are not possible. (auth)

**29024** FOURIER ANALYSIS OF THE LIGHT CURVES OF ECLIPSING VARIABLES. II. Kopal, Z. (Manchester Univ. (UK)). Astrophys. Space Sci.; 35: No. 1, 159-170(Jun 1975).

The aim of the present paper will be to extend the Fourier methods of analysis of the light curves of eclipsing binaries, outlined in the previous communication (Kopal, 1975) in connection with systems whose components would appear as uniformly bright discs, to systems whose components exhibit discs characterized by an arbitrary radially-symmetrical distribution of brightness-i.e., an arbitrary "law of darkening" towards the limb-be it linear or nonlinear. Fundamental equations will be set up which govern the light changes arising from the mutual eclipses of limb-darkened stars-be such eclipses total, partial or annular; and a closed algebraic solution for the elements of the occultation eclipses terminating in total phase will be given. Such a solution proves to be no more complicated than it turned out to be for uniformly bright discs in the previous paper; and calls for no special functions for the purpose. The case of transit eclipses terminating in an annular phase, of partial eclipses of occultation or transit type, will be similarly dealt with by Fourier methods in the next paper of the present series. (auth)

**29025** FOURIER ANALYSIS OF THE LIGHT CURVES OF ECLIPSING VARIABLES. III. Kopal, Z. (Manchester Univ. (UK)). Astrophys. Space Sci.; 35: No. 1, 171-183(Jun 1975).

The aim of the present paper will be to extend the new methods of analysis of the light curves, of eclipsing binary systems, consisting of spherical components, by Fourier approach to eclipses of transit type–which arise when the eclipsing component happens to be smaller of the two. The present principal concern will be transit eclipses, terminating in annular phase, of stars characterized by arbitrary radially-symmetrical distribution of brightness over their apparent discs–a phenomenon which will cause the light of the system to vary continuously during annular phase. An outline of the problem at issue will be given. An analysis of light changes arising in the course of partial phases of transit eclipses; and an analysis of the corresponding light changes during annular phase are given. Unlike for occultation eclipses considered in the previous paper (cf Kopal, 1975b), the moments $A_{2m}$ of the light curves due to eclipses of transit type can again be expressed in terms of the geometrical elements of such eclipses in a closed form for limb darkening characterized by any value of n; but the use of such functions will require auxiliary tables (now in preparation) for applications to practical cases. A parallel treatment of partial eclipses of the occultation or transit type–eclipses which stop short of totality or annular phase–is being postponed for a subsequent communication. (auth)

**29026** CHEMICAL POTENTIAL EFFECTS ON NEUTRINO DIFFUSION IN SUPERNOVAE. Mazurek, T. J. (Harvard Coll. Observatory, Cambridge, Mass. (USA)). Astrophys. Space Sci.; 35: No. 1, 117-135(Jun 1975).

Typically collapsing supernova hydrodynamic computations assume LTE neutrino transport and impose photon-like behavior, i.e., fix the neutrino chemical potentials at zero. The validity of the latter condition is investigated in the diffusion approximation to transport. A coupled system of diffusion equations for energy and lepton number is solved in a collapsing supernova ambience. The results indicate a substantial growth in the neutrino chemical potential for densities above $10^{12}$gm cm$^{-3}$. The rate of energy transport is affected significantly by the concomitant increases in Fermi integrals and gradients in chemical potential counter to those of temperature. It is found that the extent of neutrino particle/antiparticle interaction also affects energy diffusion rates. Thus the photon-like condition on neutrino transport may misrepresent supernova energetics substantially. An extension of the usual Sn transport to include lepton characteristics is deemed necessary for a definitive answer to the neutrino transport supernova question. (auth)

**29027** PULSED GAMMA-RAY EMISSION FROM NEUTRON AND COLLAPSING STARS AND SUPERNOVAE. Bisnovatyi-Kogan, G. S.; Imshennik, V. S.; Nadyozhin, D. K.; Chechetkin, V. M. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). Astrophys. Space Sci.; 35: No. 1, 23-41(Jun 1975).

Three mechanisms generating pulsed $\gamma$-ray emis... at late stages of stellar evolution are investigated: $\gamma$-ray burst produced by the absorption of neutrino emission of a collapsing star in its envelope; $\gamma$-ray burst of thermal emission when the outer layers of a compact star ($R = 0.01$–$0.1\ R_\odot$) are heated up by a powerful shock wave; and $\gamma$-ray emission due to ejection of matter from neutron stars at an active stage of their existence. From the mechanisms of $\gamma$-ray emission examined here the mechanism connected with the ejection of matter from neutron stars seems to be the most promising as far as the interpretation of observations is concerned. (auth)

**29028** X-RAY LINES FROM ACCRETING BLACK HOLES. Meszaros, P. (Cambridge Univ. (UK). Inst. of Theoretical Astronomy). Astron. Astrophys.; 35: No. 2, 171-176(Oct 1974).

The x-ray emission line spectrum of black holes surrounded by accretion disks is considered. For steady-state disks, the expected line strengths, equivalent widths, and broadening are calculated. This is done for the L$\alpha$ line of $S^{+15}$, using a representative set of disk parameters, and for the intercombination and forbidden lines of $Fe^{+24}$, for a range of disk parameter. The values predicted differ from those of other models of x-ray sources, and are such that experimental detection appears feasible. (auth)

**29029** SEARCH FOR SUPERNOVA REMNANTS IN THE VICINITY OF PULSARS. Weiler, K. W.; Goss, W. M.; Schwarz, U. J. (Rijksuniversiteit Groningen (Netherlands). Kapteyn Astronomical Inst.). Astron. Astrophys.; 35: No. 3, 473-477 (Oct 1974).

An area of approximately on square degree was studied around the six pulsars PSR 0329 + 54, PSR 0525 + 21, PSR 0809 + 74, PSR 0823 + 26, PSR 0904 + 77 and PSR 0950 + 08 with the Westerbork Synthesis Radio Telescope (WSRT) at $\lambda$ 21 cm to search for extended regions of radio emission. To the limit of sensitivity of the WSRT, one finds in no case a significant candidate for a supernova remnant or a pulsar "ghost". In four of the six cases the pulsar is determined. Additionally, the unrelated radio sources in the field are described. The sensitivity of the WSRT to extended sources is discussed. (auth)

**29030** RADIATIVE TRANSFER IN HOMOGENEOUS SPHERICAL SHELL ATMOSPHERES. Viik, T. Publ. Tartu. Astrofiz. Observ.; 42: 3-21(1974).

Integral equations are obtained for the source function of a homogeneous, isotropically scattering spherical shell atmosphere both with internal and external sources and with various types of cores. Examples of numerical solutions of these equations with fixed parameters are given. (auth)

**29031** MODIFIED REGIONAL AVERAGING METHOD. Viik, T. Publ. Tartu. Astrofiz. Observ.; 42: 22-37(1974).

A modified regional averaging method is derived for solving the equation of radiative transfer in the case of a spherical layer. The method takes properly into account the curvature of atmospheric layers and it can be easily generalized for the case of anisotropic scattering. Numerical examples indicate that the modified regional averaging method is somewhat more accurate than the originally proposed method of Chou and Tien or the modified Eddington method of Pomraning. (auth)

**29032** LONG-PERIOD VARIABLE YY CEPHEI. Albo, Kh. Publ. Tartu. Astrofiz. Observ.; 42: 176-179(1974). (In Russian).

Using the photographic plates of the Tartu Observatory, the light curve of YY Cep is obtained. (auth)

**29033** PHOTOELECTRIC OBSERVATIONS OF VW CEPHEI. Sorgsepp, L.; Albo, Kh. Publ. Tartu. Astrofiz. Observ.; 42: 103-165(1974). (In Russian).

In 1965–1968 photoelectric measurements of VW Cep in the yellow, blue and ultraviolet colors were carried out by means of two 20" Cassegrain reflectors with conventional photometers. Two stars, a and b, (see Fig. 1) were used for comparison, and the magnitude differences $\Delta m = m_{var} - \frac{1}{2}(m_a + m_b)$ have been determined. The extinction corrections were quite small and have been neglected. The individual values of $\Delta m$ are given in Tables 1, 2, 3 and presented in Figures 2–16. (auth)

**29034** TECHNIQUE OF QUANTITATIVE SPECTRAL CLASSIFICATION OF F5–G5 STARS ACCOUNTING FOR EFFECTS OF METAL ABUNDANCE. Malyuto, V. Publ. Tartu. Astrofiz. Observ.; 42: 94-102(1974). (In Russian).

The possibility has been found to diminish the influence of metal abundance on quantitative spectral class determinations by means of using special selected criteria. Some combinations of line depth ratios are proposed in order to segregate dwarfs with different metal content. The possibility of segregation of metal deficient stars lying above main sequence is briefly discussed. (auth)

**29035** VODORODNYE EMISSIONNYE LINII V SPEKTRAKH RANNIKH ZVEZD. (Hydrogen Emission Lines in the Spectra of Early Type Stars). Il'mas, M. Tartu; Akademiya Nauk Estonskoi SSR (1974). 35p.

The Balmer decrement of moving envelopes, if statistical equilibrium is maintained both by the radiative and collisional ionization, and excitation, has been calculated. It appears that the Balmer decrement becomes flatter if the bound-bound transitions by the radiation of the central star are taken into account. The results obtained have been compared with the observational data of Be stars. The transparency of the stellar envelopes for hydrogen lines has been evaluated. In comparison with early-type Be stars the Balmer decrement of late-type Be stars is steeper and the stellar envelope is more transparent for hydrogen line radiation. (auth)

**29036** OCCURRENCE OF PLANETARY NEBULAE IN OPEN STAR CLUSTERS. Ziznovsky, J. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 26: No. 4, 248-251 (1975).

The association of planetary nebulae with open star clusters is investigated on the basis of their apparent and space distribution between +15 and –15° galactic latitude. No association was observed. (auth)

**29037** PHOTOELECTRIC OBSERVATIONS OF EPSILON AURIGAE OUT OF ECLIPSE. Albo, Kh.; Sorgsepp, L. Publ. Tartu. Astrofiz. Observ.; 42: 166-175(1974). (In Russian).

Three-color photoelectric UBV observations of $\epsilon$ Aur during the interval February 14 to May 10, 1968 are presented in Table 2 and Figure 1. A flare of the star has been observed (see Fig. 3). (auth)

**29038** PRE-ERUPTION LIGHT CURVES OF NOVAE. Robinson, E. L. (Univ. of Texas, Austin). Astron. J.; 80: No. 7, 515-524(Jul 1975).

A catalogue of all published preeruption photometry of novae is presented, and preeruption light curves are constructed for 11 of the stars. With the possible exception of BT Mon, the preeruption and posteruption magnitudes are the same for all 18 stars for which both magnitudes are known. Twelve stars have well-defined preeruption light curves. Six of the 12 show changes in their light curves in the 1-15 yr prior to their eruption. Five of the six stars show a rise in brightness by 0.25 to 1.5. None of the available theories of the nova eruption can account for this preeruption rise. RR Tel became a long-period regular variable prior to its eruption. It is argued that the behavior of RR Tel suggests that the M5 III star in the binary must control the eruption. The preeruption and posteruption light curves of one star, V446 Her, are different. The prenova varied irregularly by almost 4 mag. The postnova does not vary by more than 0.4. (auth)

**29039** EXPANDING ATMOSPHERE OF THE OF COMPONENT OF THE ECLIPSING X-RAY BINARY HD 153919. Hensberge, G. (Amsterdam Univ. (Netherlands). Sterrenkundig Instituut). Astron. Astrophys.; 36: No. 2, 295-298(Nov 1974).

Mass loss rates from the OF star HD 153919 are estimated by comparing the observed P-Cygni profiles with those theoretically computed using the method described by Lucy (1971). The observed profiles are best reproduced by adopting a rate of mass loss of about $2 \times 10^{-5}$M(sun)/yr, and assuming an outward increasing expansion velocity (which is compatible with the observations). The relation between the mass loss rate obtained and the one needed to produce the observed x-ray intensity is discussed, and the agreement is found to be satisfactory. (auth)

**29040** SUPERFLUIDITY IN PULSARS. Tsakadze, J. S.; Tsakadze, S. J. (Inst. of Physics, Tbilisi, USSR). Usp. Fiz. Nauk; 115: No. 3, 503-519(Mar 1975). (In Russian).

A pulsar is a neutron star of relatively small size with radius $R \sim 10^6$ cm and a mass equal approximately to the mass of the sun. The name pulsar is derived from its ability to increase its brightness periodically. According to present concepts a pulsar has a structure of a solid iron crust on the outside having a thickness $d \sim 3$ km and a superfluid neutron liquid on the inside. From experiments with superfluid helium, which are described, it is concluded that at least two types of acceleration can take place in pulsars. First there is an acceleration of the solid part of a pulsar (caused by a mechanism of star quaking) with subsequent rotation of the superfluid neutron liquid. The second type of acceleration involves the superfluid liquid (caused by the formation of metastable eddies) with subsequent acceleration of the solid pulsar crust. On the basis of these studies it is concluded that a two-component model of a neutron star can explain the existence of all the characteristic relaxation times of variables brightness observed in nature for neutron stars. (SJR)

**29041** COPERNICUS: X-RAY OBSERVATIONS OF 3U 0750-49. Babcall, J. N. (Princeton Univ., NJ); Charles, P. A.; Davison, P. J. N.; Sanford, P. W.; Kellogg, E.; York, D. Mon. Not. R. Astron. Soc.; 171: No. 3, 41P-46P(Jun 1975).

Based on the Uhuru survey, it has been suggested that there is an association between X-ray sources and bright stars (Gursky 1972). One such possible association is between 3U 0750-49 and the bright variable star V Pup. Because of their accessibility these objects have been observed in both X-rays and ultraviolet with the Copernicus telescopes. Approximately five days worth of X-ray data have been analysed from Copernicus on V Pup and HD 64740, two bright stars close to the relatively weak X-ray source 3U 0750-49. The X-ray source is almost certainly closer to V Pup than HD 64740 and the data do not completely exclude V Pup as a candidate with the confidence with which HD 64740 is ruled out. An error box is derived perpendicular to the 3U error box and of similar dimensions. Based on both error boxes the variable stars most likely to be the X-ray source are V Pup, CN Pup and CSV 1199. (auth)

**29042** EXPECTED POLARIZATION PROPERTIES OF BINARY X-RAY SOURCES. Rees, M. J. (Cambridge Univ., Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 457-465(Jun 1975).

X-rays emitted by compact sources involving neutron stars or black holes would be highly polarized. X-ray polarimetry could yield important evidence on the beaming and radiation mechanism for accreting neutron stars, and the structure of accretion discs around black holes. Interesting information could also be derived from observations of the highly polarized X-rays resulting from scattering by material in the binary system. (auth)

**29043** EVOLUTION OF HELIUM WHITE DWARFS IN CLOSE BINARIES. Webbink, R. F. (Cambridge Univ., Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 555-568(Jun 1975).

Stars of 0.10, 0.15, 0.20, 0.25, 0.35, and 0.50 $M_\odot$ have been evolved from the zero-age main sequence to extinction of the hydrogen burning shell as a white dwarf, or to the onset of the helium flash. Shell-burning models are discussed as close binary remnants. Only p-p shell burning configurations exist for 0.10 and 0.15 $M_\odot$ stars. More massive stars display strong thermal pulses at the onset of shell degeneracy and at the reversion from CNO-cycle to p-p chain in the shell. All shells are thermally unstable along the white dwarf track; only close binary systems which reach the second period of mass transfer before remnants reach this stage are therefore likely to avoid nova outbursts. (auth)

**29044** SPECTROPHOTOMETRY OF STARS NEAR THE COOL END OF THE WHITE DWARF SEQUENCE. Wegner, G. (Oxford Univ.). Mon. Not. R. Astron. Soc.; 171: No. 3, 529-536(Jun 1975).

The spectra of five stars near the cool end of the white dwarf sequence are described. Two of these, GH7-21 and W489, have CH bands and relatively weak $C_2$, metal hydride, and metal line features in their spectra and thus appear hydrogen rich and metal deficient. It is suggested that they are examples of cooled down DA stars. The stars GH7-22 and L97-12 seem to have nearly continuous spectra with weak lines of Ca I and Ca II, but other weak molecular features appear present as well. This would be consistent with them being both metal and hydrogen deficient. The spectrum of LFT 526 shows strong molecular bands, notably of MgH, and metal lines, the most important being due to Ca I, Ca II and Na I. From the reduced proper motion, this star is probably intermediate between the Main Sequence and classical white dwarfs. From the spectra of the five stars, a few hypotheses are made regarding the appearances of the spectra of cool white dwarfs and their evolution. (auth)

**29045** MAGNETOHYDRODYNAMIC ACCRETION AND THE INSTABILITY OF SMOOTH TRANS-ALFVENIC FLOW. Williams, D. J. (Univ. of Glasgow). Mon. Not. R. Astron. Soc.; 171: No. 3, 537-549(Jun 1975).

Radial accretion towards a body, in the presence of a magnetic field, is considered. It is shown that, if the flow is super-Alfvénic at infinity but sub-Alfvénic further in, a smooth transition at the Alfvén surface would be unstable. The results are generalized to show that any ideal aligned-field flow where gas passes smoothly from a super-Alfvénic region into a sub-Alfvénic region will be unstable, without exception. Comparison is made with the related problem of transition from supersonic to subsonic flow. It is concluded that super-Alfvénic flow towards a body must become sub-Alfvénic via a shock, followed by turbulent flow. Super-Alfvénic accretion has thus some sililarity to the solar wind's impinging on the Earth's magnetosphere. (auth)

**29046** BLACK HOLES 1970-1974. INSPEC Bibliography Series No. 1. London; Institution of Electrical Engineers (1974). 83p.

A bibliography of the literature published from 1970 to 1974 on black holes is presented. The following topics are included: gravitational collapse singularities, general black hole theories, Kerr solutions and rotating black holes, collapse to black holes, black hole stability, vibrations and perturbations, behavior of particles and radiation in the vicinity of black holes, energy extraction from a black hole, colliding black holes, general observational aspects, black holes in X-ray/binary star systems, and black holes in galactic nuclei and quasars. (BJG)

**29047** PERIOD DERIVATIVES OF PULSARS. Lyne, A. G.; Ritchings, R. T.; Smith, F. G. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 579-597(Jun 1975).

The period derivatives for 56 pulsars have been obtained from two sets of timing observations 1 year apart. A total of 84 period derivatives are now known. Statistical relationships between period, period derivative, magnetic field strength, luminosity, integrated pulse width and apparent age are examined. The distribution of values of period and period derivative is explained by postulating a secular decay of magnetic dipole moment. The cut-off of radio emission appears to be related to the magnetic field near the velocity of light cylinder. (auth)

**29048** NEW SPECTROSCOPIC ORBIT FOR CAPELLA. Batten, A. H.; Erceg, E. (Dominion Astrophysical Observatory, Victoria, B. C.). Mon. Not. R. Astron. Soc.; 171: No. 3, 47P-50P(Jun 1975).

Spectrograms of Capella at a dispersion of 2.4 A $mm^{-1}$ were obtained at Victoria in the fall of 1973 and the spring of 1974. From them the following orbital elements were derived for the primary component: $P = 104^d.023$ (assumed), $T_0$ = JD 2 442 119.352, $\omega = 292°$, $e = 0.014$, $K_1 = 26.06$ km $s^{-1}$, $V_0 = 29.48$ km $s^{-1}$. The new elements are closely similar to those derived by earlier observers. In particular, there is no indication of an increase in period that had been suggested by an analysis of earlier observations. (auth)

**29049** GAS AND HORIZONTAL BRANCH STAR CONTENT OF GLOBULAR CLUSTERS. Tayler, R. J.; Wood, P. R. (Univ. of Sussex, Brighton, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 467-474(Jun 1975).

The observed number of horizontal branch stars in eight globular clusters is combined with an estimate of the minimum time since the clusters last crossed the galactic plane and the assumption that stars lose $\sim 0.2\ M_\odot$ on the first ascent of the giant branch to derive the amount of gas which should be present in the clusters. It is assumed that all gas lost by stars since the last crossing of the galactic plane has been retained by the cluster. It appears that there is a discrepancy between the theoretical estimates and observations and some possible explanations of this result are discussed. If the numbers of horizontal branch stars are used in conjunction with estimates of the total cluster mass and the assumption that the initial mass function was of Salpeter type, the mass of the least massive stars at present in the clusters can be derived. It appears that stars less massive than $\sim 0.25\ M_\odot$ have preferentially escaped from the clusters. (auth)

**29050** PARTICLES ACCELERATION AT PULSAR MAGNETIC POLES. Holloway, N. J. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 619-635(Jun 1975).

Attempts have been made to explain the pulsar phenomenon in terms of a model in which electrons and ions are accelerated by large electric fields near the magnetic poles of rotating neutron stars. For reasons that are discussed it is considered that these mechanisms are not possible in the axisymmetric situations for which they were invoked, and are unlikely to exist in other situations. (auth)

**29051** STRUCTURE OF HYDROXYL MASER SOURCES. Cook, A. H. (Cambridge Univ., Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 605-618(Jun 1975).

Recent interferometric observations of hydroxyl maser sources are analysed and it is shown that radiation is observed only along isolated lines of sight characterized by a specific Doppler shift of frequency, a unique sense of circular polarization and a single transition. Some implications of this result for possible properties of pumping processes or for solutions of the equations of transfer are indicated and it is argued that the observations could be accounted for by a filter mechanism depending on a correlation between mass velocity and magnetic field in the source region. It may be that the rate of pumping is uniform throughout the source and that the filter allows stimulated emission only along a few lines of sight, at a few Doppler shifts with unique senses of polarization in single transitions. (auth)

**29052** RED VARIABLES OF THE OLD DISC AND HALO POPULATIONS. Feast, M. W. (Radcliffe Observatory, Pretoria). pp 93-100 of Stellar Instability and Evolution. Ledoux, P. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on stellar instability and evolution; Canberra, Australia (16 Aug 1973).

This paper discusses the following topics: Mira variables in globular clusters; infrared observations of globular cluster variables; carbon stars in Magellanic cloud clusters; the Se variables and the superlithium rich variables. (auth)

**29053** RECENT PROGRESS IN LINEAR AND NON-LINEAR CALCULATIONS OF RADIAL STELLAR PULSATIONS. Cox, A. N. (Los Alamos Scientific Lab., NM). pp 39-48 of Stellar Instability and Evolution. Ledoux, P. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on stellar instability and evolution; Canberra, Australia (16 Aug 1973).

This review consists of a discussion about the agreement of nonlinear calculations at very low amplitude with linear theory results, the recent computational advances in progress, the current problems especially those relating to observations, a review of current computations, and finally the presentation of some recent extensive nonlinear calculations. (auth)

**29054** THEORETICAL SITUATION. Ibens, I. Jr. (Illinois Univ., Urbana). pp 3-34 of Stellar Instability and Evolution. Ledoux, P. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on stellar instability and evolution; Canberra, Australia (16 Aug 1973).

A review is made of the status of theoretical work on the behavior of stars that evolve through the classical instability strip that extends from the region of Cepheids to the domain of RR Lyrae stars. The gross features of the classical Cepheids and the uncertainties in the theory and in the interpretation of observations are discussed. The consideration of population II variables includes a summary of gross differences between population I and population II variables and a discussion of pulsation theory. (IAA)

**29055** STELLAR INSTABILITY AND EVOLUTION: PROCEEDINGS OF THE SYMPOSIUM, CANBERRA, AUSTRALIA, AUGUST 16-18, 1973. Ledoux, P.; Noels, A.; Rodgers, A. W. (eds.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974). 209p. $28.20.

The present work contains papers in which numerous new observational data for a large variety of variable stars are presented and in which such observational data are evaluated in terms of the theory of stellar variability and its occurrence at various phases of stellar evolution. Some of the topics covered include linear and nonlinear calculations of radial stellar pulsation; the abundances and gravities of the delta Scuti, Al Velorum, and RR Lyrae stars; red variables of the old disk and halo populations; variable stars and evolution in globular clusters; nonradial pulsations of dwarf novae; the sun as a pulsating rotating star; and mass-ratio determination in contact binaries. (IAA)

**29056** KRZEMINSKY'S OPTICAL CANDIDATE FOR CEN X-3. Wickramasinghe, D. T.; Vidal, N. V.; Bessell, M. S. (Mt. Stromlo and Siding Spring Observatories, Canberra, Australia). pp 289-290 of Astronomical Society of Australia, Eighth Annual General Meeting. Vol. II. Hobart, Australia; Astronomical Society of Australia (Sep 1974).

From Astronomical Society of Australia, eighth annual general meeting; Hobart, Australia (22 May 1974).

A Roche lobe analysis was conducted in order to determine whether the available observational data concerning the star considered by Krzeminsky (1973) are consistent with the various constraints imposed by the x-ray data. The light curve synthesis program described by Strittmatter et al. (1973) was used in the analysis. It was found that the primary must be in near contact with its inner critical Roche lobe. (IAA)

**29057** INFRARED SPECTRUM AND STRUCTURE OF ETA CARINAE. Aitken, D. K.; Jones, B. (University Coll., London). Mon. Not. R. Astron. Soc.; 172: No. 1, 141-147(Jul 1975).

Maps of $\eta$ Car at 12 and 20 $\mu$ are presented with beam sizes of 2.2 and 3.7″ respectively, with 10 $\mu$ spectra taken with different beam sizes and a 20 $\mu$ spectrum of the complete source. The maps show a remarkable similarity to the visible spatial distribution and also provide evidence for more complex infrared structure. The spectra indicate an optically thin inner region surrounded by cooler thicker dust. (auth)

**29058** NON-AXISYMMETRIC RIGID ROTATOR MODEL FOR MAGNETIC STARS. Stift, M. J. (Dunsink Observatory, Castleknock, Ireland). Mon. Not. R. Astron. Soc.; 172: No. 1, 133-139(Jul 1975).

A generalized, non-axisymmetric decentered dipole model is proposed to explain asymmetric magnetic variations and phase shifts between the respective extrema of effective field and surface field of magnetic stars. Detailed models are derived for two stars and it is shown that the model can reproduce the observed magnetic variations of all well-known magnetic stars but one. (auth)

**29059** EXPLANATION OF ANOMALOUS VELOCITIES IN PULSAR SCINTILLATION PATTERNS. Uscinski, B. J. (Cambridge Univ., Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 117-132(Jul 1975).

Velocities of the interstellar medium deduced from the scintillation of pulsar signals frequently exhibit surprising features. They are sometimes very large and can reverse direction in the course of an hour or so. In cases where the pulsar is known to have a high intrinsic velocity the observed pattern velocities are often strangely low. These features are explained in terms of a model of the interstellar medium containing a shear in transverse velocities. Relatively small changes in the medium are required to reverse the high observed velocities and no intrinsic modulation of the pulsar is required. (auth)

**29060** GIANT GRAINS IN ORION. Rowan-Robinson, M. (Queen Mary Coll., London). Mon. Not. R. Astron. Soc.; 172: No. 1, 109-116(Jul 1975).

A modification of Larson's model for optically thick dust clouds is used to fit the infrared and submillimeter spectrum of the Orion nebula. For a spherically symmetric, uniform dust cloud in which the grains are composed of silicates and have radius 0.2 $\mu$m, the optical depth in the ultraviolet has to exceed 1000, and the infrared cluster would have to lie by chance in front of the center of the Orion molecular and submillimeter cloud. This conclusion would not appear to be greatly altered if the cloud is flattened or has a density gradient, or if complex ices are used instead of silicates. On the other hand, a consistent picture of the whole spectrum is obtained if silicate grains of radius ~100 $\mu$m

are used with the infrared cluster supplying the energy to the rest of the cloud. The total mass in grains would be 270 $M_\odot$, implying either an unusually low gas-to-dust ratio or a molecular hydrogen number-density greater than $10^6$ $cm^{-3}$. Even if the grains have their theoretical maximum absorption efficiency, a radius of ~3 $\mu$m is required to fit the whole spectrum. It seems plausible to assume that there is either a bimodal distribution of grain sizes, or a continuous distribution ranging from small to large grains, in the Orion cloud. (auth)

**29061** ANOMALOUS SCATTERING IN THE CRAB NEBULA. Lyne, A. G.; Thorne, D. J. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 97-108(Jul 1975).

During 1974, the width of the pulses from the Crab Nebula pulsar, PSR 0531 + 21, has increased by a factor of 10 at 408 MHz. It is shown that this is probably due to multipath scattering causing a 100-fold increase in the pulse broadening. The form of the broadening function is irregular and changes on a time scale of a few days. There is evidence that the scattering is due to an increase in turbulence within the Crab Nebula. Over this same period the radio intensity of the pulses has been remarkably low and it is suggested that the enhanced scattering is connected with this. (auth)

**29062** NUMERICAL CALCULATION OF THIN SHELL FORMATION IN SUPERNOVA REMNANTS. Falle, S.A.E.G. (Manchester Univ., Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 55-84(Jul 1975).

Numerical calculations of the evolution of supernova remnants are carried out from the Sedov phase to the time when they merge with the interstellar medium. It is found that for some energies and densities the radiative cooling is so rapid that secondary shocks are produced. A criterion for this is derived and used as a basis for a dynamical classification of supernova remnants. The interstellar magnetic field is included in the calculations. It is found that the magnetic field may prevent secondary shocks and also that it affects the ultimate fate of the energy of the explosion. The results also suggest that it may make some remnants oblate and some prolate in a uniform field. (auth)

**29063** LUMINOSITIES OF THE BETA CANIS MAJORIS VARIABLES, THE ZERO AGE MAIN SEQUENCE AND THE DISTANCE OF THE SCO-CEN ASSOCIATION. Balona, L. A.; Feast, M. W. (Royal Observatory, Cape Town). Mon. Not. R. Astron. Soc.; 172: No. 1, 191-203(Jul 1975).

The H$\gamma$-luminosity calibration of Balona & Crampton is used to derive the zero age main sequence. This is about 0.2m brighter than Blaauw's. The H$\gamma$ calibration is applied to the $\beta$ CMa variables. The results are consistent with a theoretical P-L-C relation. The pulsation constant, Q, is 0.027 ± 0.001 implying that the variables pulsate in the first overtone. The variables fall in the S-bend region of evolution. Contrary to previous work the slope of the instability strip is not inclined to the S-bend locus in the $M_{bol}$-log $T_e$ diagram. The calibration is consistent with the interferometric absolute magnitude of $\alpha$ Vir and the astrometric distances of $\beta$ CMa stars in Sco-Cen. It is brighter by 0.3m than the absolute magnitude calibration of Jones and Shobbrook. There is a serious discrepancy between the mean astrometric distance modulus of Sco-Cen (5.78m) and the Hy modulus (6.46m). It seems possible that the cut-off applied to eliminate poor proper motions may have significantly biased the astrometric distance. A difference of 0.24m in the modulus of Sco-Cen derived from the H$\gamma$ and from the Strömgren $\beta$ index may be partly due to inclusion of a temperature term in the H$\gamma$ calibration but not in the $\beta$ calibration. (auth)

**29064** MAGNETIC AND X-RAY STARS. Dauvillier, A. (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France). Bull. Cl. Sci., Acad. R. Belg.; 60: 1060-1069(1974). (In French).

These two types of stars are discussed by considering them as dense pairs, the first being a white dwarf and the second a neutron star. It is shown how this concept makes it possible to interpret the properties of Babcock stars and the x-ray star HZ Herculis. (tr-auth)

**29065** GLOBULAR CLUSTER NGC 288. Alcaino, G. (European Southern Observatory, Santiago de Chile). Astron. Astrophys., Suppl. Ser.; 21: No. 1, 15-24(Jul 1975).

A BV photometric investigation of the Globular Cluster NGC 288 situated in the direction of the South Galactic Pole was carried out using the 1m telescope of Cerro La Silla (ESO) for the photoelectric work and the 1m telescope of Cerro Las Campanas (CARSO) for the photographic work. Sixteen stars were observed photoelectrically; the limiting magnitude is V = 15.98. Using this sequence 280 stars were measured photographically. The derived apparent distance modulus is (m−M) app. = 14.80m. The reddening E(B−V) = 0.05m. The true distance modulus is $(m-M)_0$ = 14.65. The distance is 8.5 kpc from the sun and the galactic plane and 12 kpc from the galactic center. The main feature of the color magnitude diagram is the presence of a large sample of blue horizontal branch stars in the range $-0.23 < (B-V) < 0.03$. Due to the undefined position of the horizontal branch it is difficult to determine its metallicity from the $\Delta V$ method; but the average steepness of the giant branch suggests that this cluster ranks among those of medium metallicity richness. (auth)

**29066** SPECTRAL CLASSIFICATION OF Ap AND Am STARS. Floquet, M. (Observatory, Meudon, France). Astron. Astrophys., Suppl. Ser.; 21: No. 1, 25-32(Jul 1975). (In French).

The spectra of 40 Ap stars and 69 Am stars have been analyzed. For most of them, the classification is confirmed. This analysis was done on plates taken with a slit spectrograph. (auth)

**29067** SPACE DISTRIBUTION OF M GIANTS IN THE WARNER AND SWASEY LUMINOSITY FUNCTION FIELD LF 13. Vleeming, G.; The, P. S. (Univ., Amsterdam). Astron. Astrophys., Suppl. Ser.; 21: No. 1, 33-50(Jul 1975).

The present paper is the third in a series, concerning the space distribution of M giants in Southern Milky Way regions. In the previous papers the results are given of a study in the Warner and Swasey Luminosity Function Field LF 15 (The et al. 1974) and LF 14 (Vleeming 1974). In the present study a survey of M-type stars has been made in a square field of 3° × 3° in LF 13, centered at Ra = 10h18m, Dec. = −52°18′ (1950). Using Malmquist-Schalen's method, space densities have been calculated for the M2−M4, M5−M6.5, and M7−M9 groups. By means of von Seeliger's method the results are then corrected for interstellar absorption, which, as function of distance, is determined using data of M2, M3, and M4 stars and those published by Wooden II (1971). A comparative discussion is then given of the results for LF 15, LF 14, LF 13, for Westerlund's (1965) Selected Area 193 and for a field in Puppis by Kirton and FitzGerald (1974). (auth)

**29068** MEAN ENERGY TRANSFER TO BLACK AND GRAY TRACKS OF STARS, PRODUCED BY 10 GeV PROTON. Vogel, A. (Institutul Politechnic Gheorghe Gheorghiu-Dej, Bucharest). Stud. Cercet. Fiz.; 27: No. 2, 207-211(1975). (In Rumanian).

The results of measurements made on 200 stars produced by collisions between 10 GeV protons and emulsion nuclei are given. The particle energy was determined by range and ionization measurements. The dependence of the mean energy transfer to black and gray tracks on the number of such trakcs is parabolic when no distinction is made between the stars formed on the two types of nuclei present in the emulsion (C, N, O) and (Br, Ag) and linear when only the heavy nuclei are taken into account, as required by the evaporation theory. (auth)

**29069** RAPIDLY ROTATING POLYTROPES AS A NET OF SINGULAR PERTURBATION PROBLEMS. Smith, B. L. (Toronto Univ., Ontario (Canada). Dept. of Mathematics). Astrophys. Space Sci.; 35: No. 2, 223-240(Jul 1975).

An analytical method is presented which determines completely the structure of rotating polytropes. It is shown that the basic Chandrasekhar expansion is of local validity only and must, for a comprehensive description, be supplemented by further locally valid expansions. Although these further expansions have insufficient boundary conditions for unique determination the fact that each is, in principle, derived from the same exact solution leads to an asymptotic matching principle which supplies the missing constraints. The case n = 1.5 is considered in detail and third order results are presented which appear to be at most $^1/_{18}$% in error. (auth)

**29070** EXPLOSIVE AND ERUPTIVE STARS. Schartzman, E. (Meudon Observatories, Hauts-de-Seine, France). pp 117-121 of Stellar Instability and Evolution. Ledoux, P. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on stellar instability and evolution; Canberra, Australia (16 Aug 1973).

A summary of the main results and problems concerning explosive and eruptive stars is given. The way in which the observations are related to the internal structure problems is briefly explained. Suggestions for further work are made: dynamo theory, supersonic turbulence, stability of the envelope of T $\tau$ stars; rate of exchange of matter in close binary as the final clue to the thermal runaway theory of novae. (auth)

**29071** NON-RADIAL OSCILLATIONS. Ledoux, P. (Univ., Liege). pp 135-173 of Stellar Instability and Evolution. Ledoux, P. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on stellar instability and evolution; Canberra, Australia (16 Aug 1973).

The problem of the adiabatic nonradial oscillations of spherical stars is reviewed and results recalled for a variety of models.

The anomalous behavior of the eigenfunctions for highly condensed models is related to the apparent mobile singularities depending on the eigenvalues. Tables of Q-values are provided to facilitate possible applications to variable stars. In the case of the gravity modes, the existence of multiple spectra, some stable (g/plus/ modes) and some unstable (g/-/ modes) if superadiabatic and subadiabatic regions alternate, is discussed. As far as vibrational stability is concerned, a general expression is given for the "damping coefficient." Attention is drawn to the possibility for g(plus) modes of becoming vibrationally unstable under the effect of various factors and in various models, including the sun where this was advocated as a possibility of relieving the neutrinos difficulty. Finally, the present status of the most obvious candidates among variable stars for nonradial oscillations, the beta Canis Majoris stars and the rapid blue variables (white dwarfs) is briefly reviewed. (auth)

**29072** ROTATIONAL INSTABILITIES AND STELLAR EVOLUTION. Zahn, J. P. (Nice Observatory). pp 185-195 of Stellar Instability and Evolution. Ledoux, P. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on stellar instability and evolution; Canberra, Australia (16 Aug 1973).

This review deals with the local instabilities arising when the effects of rotation are taken into account in the evolution of a nonmagnetic star. The Rayleigh and shear instabilities will be examined under the conditions prevailing in radiative zones where the effect of density stratification, thermal diffusion, viscosity and varying chemical composition must be taken into account. The possible consequences on the evolution of a star are finally outlined. (auth)

**29073** APPARENT RADII AND OTHER PARAMETERS FOR 116 A5V-F5V STARS OF THE CATALOGUE OF GENEVA OBSERVATORY. Fracassini, M; Pasinetti, L. E.; Pelagatti, G. (Osservatorio Astronomico di Milano-Merate, Italy). Astrophys. Space Sci.; 35: No. 2, 313-320(Jul 1975).

Preceding research on 172 B5V-A5V stars (Fracassini et al., 1973) has been extended to cover 116 A5V-F5V stars of the catalogue of Geneva Observatory (Rufener, 1971), to test the validity of the method for later type stars. Satisfactory agreement is found between these results and those obtained by Gaposchkin (1958) using data from 82 eclipsing binary systems. Furthermore, the results also seem to confirm that the Sun has an absolute radius larger than that averaged from F5V-GOV stars. There is also a good agreement with the apparent radii of $\alpha$ Aql and $\alpha$ C Mi determined by Hanbury Brown et al. (1967, 1974). Three stars which are anomalous in the log $\alpha''$ vs $m_v$ diagram have been included. No systematic differences among the absolute radii of stars of the same spectral type, in the Hyades, Pleiades and Praesepe, have been found. (auth)

**29074** STRUCTURE OF POLYTROPIC MODELS OF STARS CONTAINING POLOIDAL MAGNETIC FIELDS. Miketinac, M. J. (Cape Town Univ. (South Africa)). Astrophys. Space Sci.; 35: No. 2, 349-362(Jul 1975).

Polytropic models of axially-symmetric equilibrium stars of infinite conductivity with poloidal magnetic fields are constructed by numerical integration of the exact equations governing internal structure. The mathematical method used, a further generalization and improvement of Stoeckly's method, allows the construction of a sequence of equilibrium models starting with a spherically symmetric star (when no magnetic field is present) and terminating with a doughnut-shaped object (for a very strong magnetic field)—a fact already shown by Monaghan. Detailed results are given only for two polytropes with the index n = 1.5 and 3.0, although any other value of n greater than or equal to one could have been selected. Contrary to Monaghan's results, it is found that along the sequence of configurations for n = 3.0 the ratio of the magnetic and gravitational energy peaks out before a doughnut-shaped configuration is reached; but this effect does not characterize the n = 1.5 sequence. The calculations confirm, however, another result of Monaghan asserting that the magnetic field is a fairly insensitive function of the polytropic index. (auth)

**29075** WHITE HOLES AND HIGH ENERGY ASTROPHYSICS. Narlikar, J. V.; Apparao, K.M.V. (Tata Inst. of Fundamental Research, Bombay (India)). Astrophys. Space Sci.; 35: No. 2, 321-336(Jul 1975).

The role of exploding objects in high-energy astrophysics is discussed. Quantitative results are obtained for the simple case of the canonical white hole which explodes from a singularity and consists of pressure-free matter in the comoving frame of reference. General relativity is used for calculating the dynamical results. Applications to x-ray background, transient x-ray sources, $\gamma$-ray bursts and high energy cosmic rays are considered. White holes of more general types are discussed in a qualitative manner. (auth)

**29076** EVOLUTION OF MASSIVE CLOSE BINARIES. I. The X-ray Binary Stage. de Loore, C.; de Greve, J. P. (Brussels Univ. (Belgium). Inst. d'Astronomie et d'Astrophysique). Astrophys. Space Sci.; 5: No. 2, 241-247(Jul 1975).

X-ray binaries such as Cen X-3, Cyg X-1, Vela X-1, 2U1700-37, SMC X-1, Cir X-1, with periods ranging from 2.28d, are probably evolution products of massive binary systems. The massive primary starts losing mass after core hydrogen burning and undergoes a supernova explosion. The evolution of binary systems consisting of a 20 $M_\odot$ primary and secondaries of respectively 14, 10, 8, and 6 $M_\odot$ was computed from Main Sequence stage through the x-ray phase, until the second mass transfer phase. Estimates were performed for the evolution of a secondary of 4 $M_\odot$. It may be seen that some of these systems durint their x-ray phase match the observed mass ratios and periods. (auth)

**29077** PECULIAR A-STARS AND PLANETARY SYSTEMS. Drobyshevski, E. M. (AN SSSR, Leningrad. Fiziko-Tekhnicheskij Inst.). Astrophys. Space Sci.; 35: No. 2, 403-408(Jul 1975).

A suggestion is put forward that a number of spectral anomalies observed in some A-stars (Am and Ap-stars) may be due to the existence of planetary systems. Terrestrial type planets condense in matter exchanged between components of close binaries. Exchange of matter takes place at the stage of system formation and in later stages of evolution, with both late and early stars. If the outer layers of components in a system do not become renewed by mixing or outflow, then surface anomalies in the chemical composition of stars onto which fall some of the forming planetoids may serve as evidence of the formation of planets. (auth)

**29078** HYDROCARBON MOLECULES IN CARBON STARS. Tarafdar, S. P.; Wickramasinghe, N. C. (University Coll. of South Wales and Monmouthshire, Cardiff (UK)). Astrophys. Space Sci.; 35: No. 2, L41-L45(Jul 1975).

It is shown that the 10-13 $\mu$ band observed in the spectra of some carbon stars could arise from simple hydrocarbon molecules, especially of the type $C_nH_{2n}$. These molecules could be present in circumstellar dust shells which are responsible for the 1000 K black-body excess observed for these stars, and the emission band is produced by collisional excitation. (auth)

**29079** AN EXACT ANALYTIC SOLUTION FOR AXIALLY-SYMMETRIC EXPLOSION IN A SPHEROID. Bhowmick, J. B. (Dept. of Mathematics, St. Xavier's College, Calcutta, India). Astrophys. Space Sci.; 35: No. 2, L35-L39(Jul 1975).

The BK theory as modified by Sachdev and Kogure and Osaki is applied to a point explosion in a spheroid with exponentially decreasing density distribution. Similar results to those of Sakashita are obtained but without the assumption of the mass concentration at the shock surface. (auth)

**29080** PARAMETRIC CONVERSION AND AMPLIFICATION OF LIGHT IN MOVING MEDIA. Lerche, I. (Chicago Univ., Ill. (USA). Enrico Fermi Inst.). Astrophys. Space Sci.; 35: No. 2, 363-388(Jul 1975).

Calculations are presented which should be of interest in connection with the problem of radiative transport through the magnetospheres of pulsars and the envelopes of quasars, where not only are particle speeds of the order of the speed of light expected, but also variations of refractive index with frequency and position. The calculations show that by shining monochromatic light normally onto an interface between two media of different refractive indices it is relatively easy for the transmitted radiation to be spread out in frequency and of higher total intensity than the incident radiation. In asserting this it is assumed that the boundary between the two media is moving non-uniformly in time. Altogether, the calculations reported indicate that the production of broad-band, high-intensity radiation from relatively weak monochromatic light is a process which is likely to occur in most astrophysical objects where it is believed, or suspected, that rapid motions and spatial variations occur. (auth)

**29081** PHOTOMETRIC STUDY OF VZ HYDRAE. Padalia, T. D.; Srivastava, R. K. (Uttar Pradesh State Observatory, Naini Tal, India). Astrophys. Space Sci.; 35: No. 2, 249-254 (Jul 1975).

The photoelectric elements of the system VZ Hydrae have been redetermined in U, B, and V colors. The results are at variance from those given earlier by Walker. The color of the system has also been given. The system is a detached one. (auth)

## Quasi-Stellar, Radio, and X-Ray Sources

*Refer also to abstracts 28982, 29041, 29076, 29080, and 29173.*

**29082** X-RAY AND gamma-RAY ASTRONOMY AT THE TURNING POINT. Peterson, L. E. (Univ. of California, San Diego, La Jolla). pp 8.1-8.26 of Seventh Space Congress, Technology Today and Tomorrow. Cocoa Beach, FL; Canaveral Council of Technical Societies (1970).

From 7th space conference; Cocoa Beach, FL (22 Apr 1970).

Since 1962, approximately 40 point x-ray sources have been isolated, only about six of which have been identified with known radio or optical objects or have been studied over the 1–300 keV energy range. Data on the x-ray fluxes, positions, sizes and spectra of these sources have provided new information of considerable astrophysical significance and indicate that the exploratory stage of x-ray astronomy is now over. At higher energies, confirmation of a diffuse flux to 6 MeV and the successful detection of 100 MeV gamma-rays from the galaxy indicate the necessity of further exploratory experiments. Satellite borne instruments on a larger scale than previously implemented will be needed to take advantage of the unique opportunity now available for advancing high-energy astrophysics. (auth)

**29083** COMMENT ON GAMMA RAY LINES FROM $^4$He. Kozlovsky, B.; Ramaty, R. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Astron. Astrophys.; 36: No. 2, 307-308(Nov 1974). 9 refs.

It is pointed out that excited states of $He^4$ cannot produce gamma ray line emission of astrophysical significance, contrary to a recent suggestion of Reina et al. (1974). (auth)

**29084** TIDAL EVOLUTION OF MASSIVE X-RAY BINARIES. Sutantyo, W. (Amsterdam Univ. (Netherlands). Sterrenkundig Instituut). Astron. Astrophys.; 35: No. 2, 251-257(Oct 1974).

The tidal evolution of known massive X-ray binaries is considered in order to explain why in most cases their orbits are nearly circular. Only the tidal interaction during the main-sequence life time of the primary (which is assumed to be a 20 $M_\odot$) is considered starting after the supernova explosion which produced the compact object. Assuming that at the final stage of the tidal evolution the orbit is circular and the orbital motion is synchronized with the rotation of the primary, a lower limit of the mass of the compact object can be determined. The mean viscosity required to circularize the orbit of Vela X-1 in a given time interval is at least one order of magnitude higher than for the other systems due to the large orbital period of this system; this may explain why the orbit of this system has not yet been circularized. Assuming the tidal evolution to take place in less than $5 \times 10^6$ years (the approximated age of the systems) the lower limit of the mean viscosity required to circularize the orbit of all systems, except Vela X-1, is about $10^{12}$ to $10^{14}$ g cm$^{-1}$ s$^{-1}$. Such high viscosities can be produced by magnetic viscous forces if magnetic fields with a strength of a few gauss are present. (auth)

**29085** INTERPRETATION OF THE OBSERVED COMETARY SCINTILLATIONS. Ip, W. H.; Mendis, D. A. (California Univ., La Jolla, San Diego (USA). Dept. of Applied Physics and Information Science). Astrophys. Space Sci.; 35: No. 1, L1-L4(Jun 1975).

Strong fluctuations in the intensity of the radio source PKS 2025-15 at 327 MHz has been reported during its occultation by the plasma tail and head of Comet Kohoutek (1973f) a few days after its perihelion passage (Ananthakrishnan et al., 1975). Low-frequency fluctuations with an average period $\tau \sim 10$ s were observed on January 5, 1974 initially when the radio source was about $6 \times 10^5$ km away from the nucleus in the tailward direction and continued until it was about $8 \times 10^4$ km away from it in the same direction, when the fluctuations ceased rather abruptly. No further fluctuations were seen during the rest of the observing period when the radio source traversed very close to the nucleus and across the sunward portion of the cometary head. These authors argue rather convincingly that the observed fluctuations are genuinely of cometary origin, and not spurious in the sense of being of either ionospheric or solar origin. They have discussed the possibility that these intensity fluctuations are caused by the passage of the radio waves from the source through an irregular cometary plasma as in the case of the observed interplanetary scintillations. (auth)

**29086** 5C5 SURVEY OF RADIO SOURCES. Pearson, T. J. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 475-505(Jun 1975).

The 5C5 survey, made with the Cambridge One-Mile telescope, covers an area about 4° in diameter at 408 MHz centred at $\alpha = 09^h\,40^m$, $\delta = 47°\,00'$ to a limiting flux density of $8.7 \times 10^{-29}$W m$^{-2}$ Hz$^{-1}$ at the centre, and a concentric area of diameter about 1° at 1407 MHz to a limiting flux density of $1.8 \times 10^{-29}$W m$^{-2}$ Hz$^{-1}$. The positions and flux densities of 230 sources observed at 408 MHz, and of 52 observed at 1407 MHz, are listed in Table I, with suggested optical identifications for some of the sources. The flux density and spectral index distributions are similar to those of the earlier 5C surveys and these is no evidence for significant anisotropy in either distribution. New observations of some 5C I sources included in the 5C5 survey show that the flux densities measured in 5C I were in error. (auth)

**29087** OBSERVATIONS OF AN ACCRETION WAKE AND PRE-ECLIPSE DIPS IN CENTAURUS X-3. Tuohy, I. R.; Cruise, A. M. (Mullard Space Science Lab., Dorking, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 33P-39P (Jun 1975).

The results are reported of seven Copernicus observations of Centaurus X-3 in the energy range 2.5 to 7.5 keV, between 1973 April and 1974 June. An abrupt absorption event was observed at phase 0.5 which is interpreted as an accretion wake sweeping through the line of sight. The wake appears to be associated with an increase in the gas density prior to an extended low state. The data support a stellar wind model for the mass transfer in the Cen X-3 system. A series of pre-eclipse dips which are due to absorption by column densities of 1 to $4 \times 10^{23}$ hydrogen atoms cm$^{-2}$ have also been detected. (auth)

**29088** ULTRAVIOLET COLORS OF QUASARS. Morgan, D. H.; Nandy, K. (Royal Observatory, Edinburgh, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 599-604(Jun 1975).

The ultraviolet continuum colors of quasars have been computed attributing the observed redshift variation of the visual quasar colors corrected for the effects of emission lines, to luminosity evolution, a general curvature of spectrum, and reddening due to intergalactic dust. For the dust model, graphite, silicate, and dust which obeys the observed interstellar extinction law have each been considered. The near ultraviolet colors are shown to provide a definite test of whether or not the visual color-redshift variation is due to dust, and if appropriate, a differentiation between the dust models proposed. (auth)

**29089** 3C219: A DOUBLE RADIO SOURCE WITH A JET. Turland, B. D. (Cambridge Univ., Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 181-189(Jul 1975).

3C 219 has been mapped at 5 GHz with the 5-km telescope. Besides the two extended outer components and a component coincident with the nucleus, a jet was found which lies along the source axis between the nucleus and a compact "head" in the Sp component. This jet is compared with jets found in other radio sources and the possibility that such jets are associated with the flow of energy from the nucleus to the outer components is discussed. (auth)

**29090** X-RAY SOURCE COUNTS AND THE X-RAY BACKGROUND FROM UHURU. Fabian, A. C. (Cambridge Univ., Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 149-157(Jul 1975).

Fluctuations in the x-ray background observed from the Uhuru satellite have been used to estimate the number counts of x-ray sources at high galactic latitude ($|b| > 20^0$). Differential counts represented by $N(S)dS = 25(\pm 10)S^{-2.5\pm0.2}dS$ fit these data adequately. It is suggested that the previous counts by Matilsky et al. and Holt et al. have been overestimated. (auth)

**29091** OPTICAL JET IN THE QUASAR 3C273. Guthrie, B. N. G.; Napier, W. M. D. (Royal Observatory, Edinburgh). Mon. Not. R. Astron. Soc.; 172: No. 1, 85-89(Jul 1975).

Various models of the optical jet in 3C 273 are discussed. The optical emission is probably due to inverse Compton scattering of infrared radiation from the quasar by a mass $\gtrsim 6 \times 10^7$ $M_\odot$. It seems that the jet was relativistically ejected along the polar axis of the quasar $\sim 10^6$ yr ago. Difficulties are encountered in applying current models of extended radio sources to the jet. (auth)

**29092** LIGHT CURVE ANALYSES OF X-RAY BINARIES. Wickramasinghe, D. T. (Australian National Univ., Canberra); Whelan, J. Mon. Not. R. Astron. Soc.; 172: No. 1, 175-179 (Jul 1975).

A comparison is made between the results of a number of programs currently in use for computing theoretical x-ray binary optical light curves. For four programs excellent agreement is found, and the small differences between them are the result of different treatments of limb darkening. The use of approximate limb-darkening laws is discussed and it is shown that the commonly used linear approximation generally tends to overestimate the "larger" light amplitude. A discrepancy between the results obtained by Hutchings and other investigators is pointed out. (auth)

**29093** FLUX DENSITIES OF CELESTIAL RADIO SOURCES AT 15.5 AND 31.6 GHz. Yokoi, H.; Yamada, M.; Akagawa, M.; Ogawa, A.; Mizuguchi, Y. (Kokusai Denshin Denwa Co., Ltd., Tokyo). Electron. Commun. Jpn. (Engl. Transl.); 57: 79-85 (Mar 1974).

This paper discusses flux densities of radio waves measured at 15.5 and 31.6 GHz emitted by radio stars Cas A, Tau A, Cyg A, Virgo A, the Orion Constellation, Venus and Jupiter. Such measurements are useful in determining the gain of large-aperture antennas for satellite communication. The spectral index of the flux density of Cas A, which had been believed to decrease rapidly above 7 GHz, was found to be constant up to 30 GHz, and the flux density of Venus was also clarified. An antenna with diameter of 7 m and a high-sensitivity radiometer in which a new beam-switching system and a low-noise parametric amplifier was built and used. Furthermore, attenuation in the atmosphere was exactly taken into account and many drift curves were averaged to get high-accuracy results. (IAA)

## Solar Phenomena

*Refer also to abstracts 28982, 28983, 28999, 29000, 29174, 29179, 29185, 29186, 29212, 29220, 29255, and 29264.*

**29094** ABSOLUTE PHOTOMETRY AND THE STRUCTURE OF THE CORONA DURING THE SOLAR ECLIPSE OF JUNE 30, 1973. Rusin, V.; Rybansky, M. (Astronomical Inst., Lomnicky Stit, Czech.). Bull. Astron. Inst. Czech.; 26: No. 3, 160-168 (1975).

The paper gives the geographic co-ordinates of the observation station and the eclipse contacts. Three photographs of the solar eclipse were used to determine the absolute values of the intensity of the white corona for all position angles. It was found that the corona was of a intermediate type with a compact wide ray above the eastern solar limb, with polar rays and an abundant structure above the western limb of the Sun. The flattening pattern of the isophotes as a function of height is similar to that in the neighbourhood of minimum solar activity. The method of determining the structure of the solar corona from pictures taken without a radial filter, when short exposures are not applied, is also described. (auth)

**29095** FLIGHT TIME OF SOLAR FAST PARTICLES FROM FLARES TO THE EARTH. III. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 26: No. 3, 181-185(1975).

Ejections of solar fast particles from flares that produce the PCA and GLE effects are considered to originate in flares with a Y-shaped phase of development at the time of their rapid blaze up. Thus we know the exact time of the ejection and escape of the particles, coincident with the first top of radio burst on mm, cm, and dm range and with peaks of very hard X-emission. Determined is the time lag of the beginning of PCA effect or of the beginning of increase of cosmic rays after the occurrence of the Y-shaped phase of the flare. With cosmic rays the delay time ranges between 3 and 85 minutes with particles producing the PCA-effect it ranges from 10 to 870 minutes. Data on further flares with a Y-phase, and on various particles effects are listed. Corrections of supplementary data for the flares and transit times of particles already published are given. Proton flares without transit time of particles the determination of which was not possible due to superposition of particle events. (auth)

**29096** INCREASE IN THE SMOOTHING OF TIME-INTENSITY PATTERNS OF PROTON EVENTS WITH DISTANCE FROM THE SUN. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 26: No. 3, 190(1975).

The decrease in the occurrence of impulse effects in proton fluxes from the active region of August 1972 with increasing distance in interplanetary space is explained by the effect of "smoothing" as a result of the increasing number of interactions of the new situation of the fields with the preceding situation. The principle of "successive impressions" is used to explain the phase delay of the onset phase of the overall pattern of the proton event with distance. (auth)

**29097** SOLAR WIND. Veselovskii, I. S. pp 7-192 of Solnechnyi Veter. Magnitosfere Zemli. Tom 4. Moscow: Izdatel'stvo VINITI(1974). (In Russian).

The present work reviews the principal results of a large number of theoretical and experimental studies of the solar wind. Data are presented on the mean parameters of the plasma and magnetic field in the interplanetary medium and on perturbations in density, temperature, velocity, chemical composition, and magnetic field in the solar wind plasma. Hydrodynamic and kinetic models of the solar wind are presented, and difficulties in steady-state description are discussed. Transport phenomena, stability, and the propagation of waves in the interplanetary medium are examined. (IAA)

**29098** CORRECTIONS OF THE TOTAL AREAS OF SUNSPOTS IN THE GREENWICH PHOTOHELIOGRAPHIC RESULTS FOR 1960. Kopecky, M.; Kopecka, F. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 26: No. 3, 158-159(1975).

In the "Greenwich Photoheliographic Results" for 1960 the total areas of sunspots are given incorrectly for about one third of the days in the first quarter of 1960. This paper gives the correct values of the sunspot areas for these days, as well as the corresponding correct values of the monthly means, the annual mean and the means by synodic revolutions of the total areas of the sunspots. (auth)

**29099** ROTATIONAL MOTIONS OF SUNSPOTS. Knoska, S. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 26: No. 3, 151-158(1975).

Drawing in the study of the rotation of sunspots from the daily drawings of the Sun, made at the Mt. Wilson Observatory in the years 1917-1924, it was found that of the 146 sunspots which rotated, 60% rotated in the ENW direction, in the N, as well as the S hemisphere. The observed rotational motion, concurrent in direction in both hemispheres, contradicts the effect of differential rotation, as well as the action of the Coriolis force. It is probably due to the dynamics of the development of the magnetic field of the group. (auth)

**29100** HARD X-RAYS FROM THE SUN. van Beek, H. F.; Hoyng, P.; de Jager, C.; Stevens, G. A. (Rijksuniversiteit Utrecht (Netherlands). Lab. voor Ruimte-Onderzoek). Ned. Tijdschr. Natuurkd.; 41: No. 9, 101-103(3 May 1975). (In Dutch).

The outer layer of the sun's atmosphere constitutes an inhomogeneous plasma. Instabilities include solar flares, which may extend to $10^4$ km., last for about 100 sec. and be in the form of hard X-rays. Types of radiation associated with solar flares, and the magnetic field effects and strengths are described. The most pronounced radiation is in the first Balmer lines of hydrogen ($\lambda$ = 6563 Angstrom). Instrumentation associated with the ESRO TD-1A satellite is outlined, and photographs show solar disturbances dated August 1972. Interpretation of the results includes the turbulence existing, which may be deduced from the form of the spectra, and the total energy from time integrals. (NL)

**29101** STATISTICAL RELATIONS BETWEEN RELATIVE NUMBERS AND FLARE INDICES. Zemanek, E. N. (Kiev State Univ.). Astrometriya Astrofiz.; No. 25, 39-48(1975). (In Russian).

The relation between the flare indices and sunspot relative numbers and recurrent relative numbers was studied. The correlation coefficients and regression equations were determined. (13 refs, 17 figs) (auth)

**29102** DISCRETE FREQUENCY SCATTERING IN SPHERICAL LAYERS SURROUNDING A POINT SOURCE. Titarchuk, L. G. (AN SSSR, Moscow. Inst. Kosmicheskikh Issledovanij). Astrophys. Space Sci.; 35: No. 1, 137-149(Jun 1975).

The scattered radiation field in homogeneously absorbing and isotropically scattering spherical layers is studied, when the isotropic point source is at the center. A complete frequency redistribution is assumed. It is shown, that on the inner boundary $r = R_0$ of the cavity, when $R_0 \gg 1$ (all radii are expressed in the path lengths), the source function $B \sim R_0^{-1} \ln^{-\frac{1}{2}} R_0$ for the Doppler profile and $B \sim R_0^{-\frac{1}{2}}$ for the Voigt and Lorentz profiles. The asymptotical behaviour of the source function B (r) significantly differs from the analogous behavior of solution for an infinite medium. (auth)

**29103** FORMATION OF GALAXIES IN THE EXPANDING INVERSE. Doroshkevich, A. G.; Zel'Dovich, Ya. B. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). Astrophys. Space Sci.; 35: No. 1, 55-65(Jun 1975).

The possibility of the formation of galaxies both during the galactic clustering of small structural units originated earlier and at fragmentation of larger formations is considered. A self-similar spectrum of long-wave perturbations is obtained. The results of numerical calculations and conclusions of Press and Schechter's (1974) work are discussed. (auth)

**29104** SHARP DIPS IN THE FLUX OF THE SOLAR LYMAN-$\alpha$ LINE DURING THE FLARES OF AUGUST 4, 7, AND 11, 1972. Martini, L.; Bischoff, K. G.; Pfau, G.; Stark, B; Ulrich, Z. Cosmic Res.; 12: No. 5, 670-672(1974).

Translated from Kosm. Issled.; 12: No. 5, 736-739(1974).

Results are reported of measurements of the flux in the L$\alpha$ line during the chromospheric flares of August 4, 7, and 11, 1972, as obtained with the Interkosmos 7 satellite. A sharp decrease in the flux was observed in each case. (auth)

**29105** SOLAR WINDS. Olmr, J.; Pinter, S. Pokroky Mat., Fyz. Astron.; 20: No. 2, 84-89(1975). (In Czech).

Data on solar winds obtained from interplanetary probes and satellites from 1958 to 1972 are tabulated, and the interaction between solar winds and the earth is discussed, with reference to particle flux rates, electron and proton densities and temperatures, and magnetic fields. (Review, 16 references) (auth)

**29106** SPECTRAL ANALYSIS OF THE TIME VARIATIONS OF SOLAR X RAYS IN THE 1 TO 8 A AND 8 TO 20 A REGIONS. Apostolov, E. M. (Geophysical Inst., Sofia); Letfus, V. Bull. Astron. Inst. Czech.; 26: No. 4, 193-198(1975).

Standard autocorrelation and power spectral analysis has been applied to the solar X-ray measurements, made on the Solrad 9 satellite in the spectral regions 1–8 Å and 8–20 Å. Daily averages of the measured values, including X-ray bursts, and daily minimum values, representing the S-component, have been used for the period from 1 January 1969 to 31 December 1972. Periods of 82, 42, 30.5, 27.3, 22.5, 20 and 11.8 days have been found in the power spectra of the time series of both the 8–20 Å data and of the 1–8 Å daily minima. Strong in power are the periods of 82 days in all power spectra and of 27 days in the 8–20 Å ones. The 27.3 day period is absent in the time series of the 1–8 Å daily averages and has been detected in this time series with relatively high power only when the logarithmic scale of the data, superpressing the large amplitudes and amplifying the small ones, was used. The period of 22.5 days is newly observed and does not occur in the time series of other solar indices. The periods different from the period of the Sun's rotation may be due to the structure of the longitudinal distribution of solar activity and its time development. (auth)

**29107** TRENDS OF FLARE ACTIVITY IN THE JULY 1974 PROTON REGION. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 26: No. 4, 203-205(1975).

Summation curves of flare activity for the proton region S 15°, CMP ? July 1974, were constructed in the same manner as for similar cases of occurrence of flares with emissions of subcosmic and cosmic radiation. As is known, these curves indicate the main trends of activity which last for several days and which describe the time distribution of the release of flare energy. It was again found that the steep trend of increased activity sets on several tens of hours prior to the occurrence of the first proton flare, which could be used, together with other methods, to forecast proton flares. (auth)

**29108** INTEGRAL BRIGHTNESS OF THE CORONA DURING THE SOLAR ECLIPSE OF JUNE 30, 1973. Rybansky, M.; Rusin, V. (Astronomical Inst., Lomnicky Stit, Czech.). Bull. Astron. Inst. Czech.; 26: No. 4, 206-210(1975).

The total brightness of the corona is determined in the standard region $1.03 \leq \rho \leq 6.00$ for the solar eclipse of June 30, 1973. The absolute photometry of this eclipse formed the basis for computing the integral brightness of the corona. The resultant value is $0.84 \times 10^{-6}$ of the total brightness of the solar eclipse. In this connection it is assumed that the value of the integral brightness of the solar corona, determined in this manner and representing an instantaneous value, may differ considerably from the average value. We are also of the opinion that the integral brightness of the corona could also be determined from satellite observations of the external corona in white light. (auth)

**29109** SOLAR X-RAY PHOTOMETER ONBOARD THE INTERKOSMOS-11 SATELLITE AND PRELIMINARY RESULTS OF OBSERVATIONS. Farnik, F. (Astronomical Inst., Ondrejov, Czech.); Valnicek, B.; Komarek, B. Bull. Astron. Inst. Czech.; 26: No. 4, 212-218(1975).

The principle and design of the new Czechoslovak instrument for measuring solar X-rays in the range of 0.4–100 keV, which operated from May to October 1974 onboard the Interkosmos-11 satellite is given. The detectors used and their effectiveness, the electronics block diagram, the transmission of observed data are described and, to conclude, the preliminary results of the observations, in particular of the flare of July 9, 1974, are given. (auth)

**29110** SPATIAL DISTRIBUTION OF X RAY, EUV, AND GHz EMISSIONS IN CONNECTION WITH THE FLARE-LOOP-CHANNEL MODEL. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.); Pinter, S. Bull. Astron. Inst. Czech.; 26: No. 4, 199-203(1975).

Flare-loop-channel model of proton flares is compared with interpretations of measured spatial distribution of some sort of radiation sources, especially with X- and EUV-emissions, carried out by the OSO-7 satellite. (auth)

**29111** RECORDINGS OF SOLAR PROTONS DURING 26–29 OCTOBER 1968. Gjerde, A.; Amundsen, R. (Univ. of Bergen). Phys. Norv.; 8: No. 1, 47-58(1975).

The composite events causing increased influx of solar particles during 26–29 October, 1968 are studied, using data from the polar-orbiting ESRO IA satellite. Details on protons of 0.1–10 MeV are presented, and their interplanetary propagation characteristics discussed. The fit of the diffusion model to the prompt event commencing 26 October suggests for 200-350 keV protons an interplanetary diffusion coefficient of $(2.8 \pm 0.7) \times 10^{20}$ $cm^2 s^{-1}$. The most likely parent flare for this event is the 1N flare of 0119 UT 26 October, occurring in McMath plage region 9740 at 32°E solar longitude. The slow decay of the event is then accounted for by co-rotation effects. The flares occurring in the same solar region on 27 October and leading to the delayed events of 29 October, did not result in prompt events seen near Earth. This shows the great variability in energetic particle propagation conditions of interplanetary space. (auth)

**29112** COSMIC RAY ANISOTROPIES LATE IN A SOLAR FLARE EVENT. Allum, F. R. (Univ. of Dallas); McCracken, K. G.; Rao, U. R.; Palmeira, R. A. R.; Fairfield, D. H.; Gleeson, L. J. Contract NAS5-9075. pp 262-280 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The detailed relationship between the anisotropy characteristics observed during late times in the decay of a solar flare event and the interplanetary magnetic field parameters is investigated. The anisotropy always is from 45 deg east of the earth-sun line. This direction is approximately perpendicular to the nominal Archimedean spiral, independent of the particle energy. The amplitude of the anisotropy increases as the magnetic field azimuthal direction shows greater departure from the radial direction. These results are discussed in terms of current ideas about solar particle propagation in the interplanetary space. (auth)

**29113** INTERPRETING THE STATISTICS RELATING SOLAR WIND CONCENTRATION TO OTHER OBSERVATIONS. Croft, T. A. (Stanford Univ., CA). pp 159-175 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Extensive measurements of the solar-wind density have been obtained by the Stanford University dual-frequency experiment aboard Pioneers 6-9. These data show that the wind often tends to be unusually dense at active times, and yet there are only weak correlations between density and other solar-wind parameters in statistical scatter plots. The most marked correlation appears with increasing velocity, attributed to pile-up at the leading edge of higher-speed streams. However, this mechanism accounts for only a small percentage of the density enhancements which are observed. It is suggested that there are conflicting mechanisms at work, and their effects tend to cancel one another in the more simple statistical analyses. Through examination of data from U. S. and Soviet spacecraft taken simultaneously, it is shown that the density appears to be unusually high during some disturbed times, and unusually low at others. Scatter plots of the same data appear featureless. (auth)

**29114** IMPLICATIONS OF POLARIZATION PROPERTIES OF TYPE III SOLAR RADIO BURSTS AT DECAMETRIC WAVELENGTHS. Mattoo, S. K.; Bhonsle, R. V. (Physical Research Lab., Ahmedabad, India). pp 41-50 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The present work analyzes some Faraday rotation measurements of type III bursts carried out by means of a two-bandwidth time-sharing polarimeter at 35 MHz. It was found that type III bursts at 35 MHz had axial ratios at the source ranging mostly between −0.15 and plus 0.20, indicating that the bursts were highly elliptically polarized, with degree of polarization varying between 20 and 100 per cent. The present results indicated that the observed value of the Faraday rotation at 35 MHz is at least two orders of magnitude less than what is theoretically expected. This low value for the Faraday rotation is discussed from the viewpoint of being possibly due to mode coupling in the earth's ionosphere or in the solar corona. (IAA)

**29115** CHROMOSPHERIC FLARE ON JUNE 11, 1972 AND RELATED PHENOMENA. Alikaeva, K. V. (Glavnaia Astronomicheskaia Observatoriia, Kiev). pp 52-62 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The present work gathers together and evaluates data obtained at various observatories and stations on the weak chromospheric flare of June 11, 1972. Magnetic field observations with polarizable

optics revealed that the flare appeared above two spots of S polarity. Magnetic field strengths for these two spots are given for two different times in Ca I (6102.7 A), Fe I (6137.0 A), and Fe I (6137.7 A) lines. Radio observation data at 10, 22, 9.5, 3.0, 1.5, 0.775, and 0.512 GHz are presented. Radiation fluxes of X-rays recorded by the satellites Vela VB and VIA,B in the intervals 1-8 A, 1-16 A, and 0.3-3 A are also given. The spectrum of a surge preceding the flare was photographed in several lines, and estimates of the population ratio of 3(3D) and n equals 7 levels for three different values of electron density are calculated and compared with observed values of the ratio in order to estimate conditions in the surge. (IAA)

**29116** SMALL SUBFLARE IN CINOF PROGRAM, 1972 JUNE 14, 1936 UT. Dodson, H. W.; Hedeman, E. R. (McMath–Hulbert Observatory, Lake Angelus, MI). pp 63-72 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

According to H-alpha and/or K3 records of McMath Plage 11926, the flare event on 1972 June 14 at 1936 UT was one of a series of four subflares that occurred in this plage between 1600 and 2030 UT. These chromospheric brightenings apparently were associated with a moderately active system of narrow filaments just beyond the southern boundary of the calcium plage. Comparison with magnetographic data shows that in general these subflares occurred in the neighborhood of a secondary neutral line near the southern boundary of the plage. The brightest H-alpha component of the 1936 UT event, however, developed over the penumbra of the large following spot of Mt. Wilson group 18859, near the eastern end of the filament system, and cut nearly perpendicularly across the closely packed cluster of magnetic contours surrounding the spot. (auth)

**29117** SOLAR PARTICLE AND RELATED INTERPLANETARY OBSERVATIONS DURING THE CAMPAIGN FOR INTEGRATED OBSERVATIONS OF SOLAR FLARES (CINOF). Shea, M. A.; Smart, D. F. (USAF, Cambridge Research Labs., Bedford, MA). pp 84-93 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The Campaign for Integrated Observations of Solar Flares was a period of extensive solar flare studies conducted June 5-29, 1972. During this time period the solar particle and interplanetary conditions were moderately complex with two significant particle increases. While it would be tempting to ascribe the impulsive increase on June 8 to a CINOF selected flare, we wish to suggest the possibility that McMath Region 11895 behind the western limb may be the principal source of this particle event as indicated by particle measurements on near-earth satellites as well as on Pioneer 6 and Pioneer 10. The absence of a significant X-ray increase at this time tends to support this assumption. After the decay of this discrete injection, a complex enhancement begins on June 13 with a recognizable increase on June 14 and a significant slow rising increase on June 16. Again the absence of any convincing classical flare associated phenomena leads to difficulty in ascribing a unique source for this particle event. (auth)

**29118** MODEL ASSOCIATING ENERGETIC STORM PARTICLES WITH FLARE SITES. Medrano, R. A.; Kantor, I. J. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil). pp 99-115 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A model to explain the so-called "energetic storm particles" events is proposed. The model assumes that the flare site is still active releasing energetic particles for some days after the occurrence of the flare. The fresh plasma released during the flare convects out the chromospheric magnetic field lines. It is found that the smoothness of these field lines (with both ends in the photosphere) can depend on the speed of the fresh plasma. This process may imply a dependence of the energetic particle diffusion across the interplanetary field lines on the solar wind speed. The singular proton event of Aug. 5, 1972 is interpreted as being an exceptional example of this kind of proton events. Proton data of the August event is presented. (auth)

**29119** ORIGIN OF THE MASS FLUX IN THE PROBLEM OF PLASMA OUTFLOW FROM THE SUN. Koniukov, M. V. (Inst. of Physics, Moscow). pp 116-118 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The present work constructs a phenomenological model describing plasma outflow from the boundary of the hydrostatic region of the sun to the supersonic flow region. A set of equations for plasma outflow without dissipation but with volume heat source form the basis for a first attempt at this model. This model, which supposes that almost laminar outflow to the hydrostatic region boundary takes place, is shown to be incomplete, so a second model is attempted. This one assumes that the plasma in the considered region can be described by the frequent collision approximation; in the region of the formation of the almost laminar outflow, energy, momentum, and mass are transferred by nonlaminar agents whose dissipation gives rise to volume sources of energy, momentum, and mass in the set of equations for the average values characterizing the plasma. A computer experiment showed the existence of the required type of solutions for the equations fitting these assumptions. (IAA)

**29120** LYMAN-ALPHA PHOTOMETER RESULTS OF THE SATELLITE DIAL. Fahr, H. J. (Univ., Bonn); Schlichter, H. D. pp 122-132 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Solar Lyman-alpha radiation resonantly scattered from geocoronal and interplanetary hydrogen has been observed from the earth's shadow region by three nitric oxide ionization chambers onboard the satellite DIAL during March through May 1970. The regenerated data have been compared with corresponding intensities given by the theoretical multiple scattering model of Meier and Mange. Systematic deviations of the observational intensities from the theoretical intensities of the spherically symmetric model can be shown to be due to the pronounced local time variations of the geocoronal hydrogen density. The indicated density anisotropy is in full agreement with other photometric findings concerning the geocoronal bulge. A deduction of the extraterrestrial Lyman-alpha background that is superimposed on the geocoronal intensities has been carried out and yields confirmation of the OGO 5 Lyman-alpha measurements. (auth)

**29121** ASYMPTOTIC BEHAVIOR OF THE SOLAR WIND TYPE SOLUTIONS IN THE OUTFLOW PROBLEM WITH THE THERMAL CONDUCTIVITY. Koniukov, M. V. (Inst. of Physics, Moscow). pp 133-143 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The existence of solutions of solar wind type for the problem of plasma outflow with thermal conductivity is examined. Beginning with a set of equations for plasma outflow in stationary spherical symmetry regime, an algorithm is described for obtaining a solution to a two-point boundary value problem. This algorithm permits the obtaining of solutions with smooth transition across the speed of sound in the singular point of saddle type over the whole range as r goes to infinity. (IAA)

**29122** INTERSTELLAR GAS PARAMETERS IN THE VICINITY OF THE SOLAR SYSTEM AND THE INTENSITY AND POLARIZATION OF SCATTERED SOLAR RESONANCE RADIATION. Blum, P. W.; Wulf-Mathies, C.; Pfleiderer, J. (Inst. of Physics, Moscow). pp 144-152 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29123** MODEL OF AN ANISOTROPY SOLAR PROTON EVENT. Palmer, D. I. (Oral Roberts Univ., Tulsa, OK); Palmeira, R. A. R.; Allum, F. R. pp 281-296 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The anisotropy of the particle distribution and its variation with time at 1 AU early in a solar cosmic-ray event can provide information on the pitch-angle scattering of the particles in the interplanetary medium. One proton event (7.6-55 MeV) is described in which the anisotropy remained large well into the decay of the omnidirectional intensity. A Monte Carlo technique which gives the pitch-angle distribution is employed to investigate two models put forward to explain the sustained anisotropy. It is shown that the observed event is consistent with a model in which the injection of particles at the sun reaches a peak 1.5 hours after flare maximum before decaying with an e-folding time of 7 hours. The

uniform diffusion coefficient in this model corresponds to a classical mean free path of 1.6 AU. (auth)

**29124** DETERMINATION OF THE RADIAL GRADIENT IN THE REGION 0.81 TO 1.0 AU USING BOTH HIGH- AND LOW-ENERGY (MORE THAN 10-GeV AND MORE THAN 52-MeV) DETECTORS FOR THE 1-AU MONITOR. Sheldon, W. R. (Univ. of Houston, TX); Bukata, R. P.; Rao, U. R. Contract NAS2-3945. pp 237-246 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A determination of the radial gradient for alpha particles (31-46 MeV/nuc) and protons with energies above 7.5 MeV and 44-77 MeV in the region 1.0-0.81 AU is presented for the solar-quiet year 1966. The determinations are based on data from the Pioneer 6 space probe. Two different detectors are used: the Deep River neutron monitor and measurements of low energy protons made on the IMP-C satellite. The average energy response of the Deep River monitor is 16 GeV, whereas the IMP-C data is for protons with energies above 50 MeV. The resulting radial gradient is found to be nearly zero for the alpha particles and slightly negative for the protons. The same qualitative results were found using the IMP-C data and the Deep River neutron monitor to measure the temporal variation in the cosmic ray intensity. The present analysis indicates that detectors over a wide range of energies are suitable for measuring the radial gradient, providing sufficient statistical precision is obtained to evaluate short-term modulation and the azimuthal separation of the detectors is not great. (auth)

**29125** INTERPRETATION OF FLARE-PRODUCED PROTON SPECTRA. Rothwell, P. L. (USAF, Cambridge Research Labs., Bedford, MA); Katz, L.; Yates, G. K.; Sellers, B.; Hanser, F. A. pp 252-261 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Flare-produced proton (1.3-40 MeV) energy spectra from the extramagnetospheric satellite OV5-6 (1969-046B) are examined for the Oct. 29-Nov. 3, 1972 period. The higher-energy portion of the spectra is further defined by simultaneous measurements obtained from the polar-orbiting satellite S72-1 (1972-076B). A turn-over in the spectra below about 4 MeV is observed. The spectral shape is examined in terms of (1) dE/dx losses in a chromospheric/coronal storage region and (2) adiabatic deceleration with an energy-dependent interplanetary diffusion coefficient. It is concluded that the data are consistent with dE/dx losses if the protons were stored at 2.0-2.6 solar radii. The data are also consistent with the adiabatic deceleration hypothesis if the diffusion coefficient (10 MeV) is about $7.5 \times 10$ to the 21st power sq cm per sec and the Jokipii lower-limit is not reached at these energies. (auth)

**29126** PROPAGATION OF SOLAR DISTURBANCES IN INTERPLANETARY SPACE. Wu, S. T. (Alabama Univ., Huntsville); Han, S. M.; Dryer, M. pp 191-203 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Time-dependent solutions of a one-fluid model of the interplanetary medium are investigated. This set of unsteady hydrodynamic equations has been written in conservation form in order to apply the Lax-Wendroff method for the solution of this problem. The initial condition is specified by a pulse at 1 solar radius. The equilibrium condition is chosen to be the steady solution of a quiet solar wind. The specified solar disturbances in this calculation are allowed to be both sub- and supersonic by the present theoretical formulation. The results are presented in terms of density, velocity, and temperature profiles of the interplanetary gas flow at heliocentric distances up to about 10 AU at any particular time. The trajectories of disturbances for various initial pulses are shown. Some 1972 solar-flare observational data are compared with these theoretical calculations. From these calculations, the effects on the interplanetary environment, due to the propagation of solar disturbances, can be determined. (auth)

**29127** JUNE 15, 1972 INTERPLANETARY EVENT. Ward, B. D. (Adelaide Univ.). pp 75-83 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The passage through space of the shock wave responsible for the large geomagnetic storm of June 1972 has been traced using the scintillations of radio sources and plasma parameters measured from spacecraft. Scintillation observations of this type provide another useful technique in detecting the propagation of such disturbances, especially in regions out of the ecliptic. The results suggest the shock originated in a flare at 0958 UT June 15 and propagated south of the ecliptic with a somewhat unusual shape. (auth)

**29128** MEASUREMENTS OF EMISSION LINE PROFILES IN THE SOLAR ULTRAVIOLET SPECTRUM. Boland, B. C.; Dyer, E. P.; Firth, J. G.; Gabriel, A. H.; Jones, B. B.; Jordan, C.; McWhirter, R. W. P.; Monk, P.; Turner, R. F. (Science Research Council, Abingdon, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 697-724(Jun 1975).

A further flight of a high resolution echelle spectrograph has been carried out on a Skylark rocket to measure solar line profiles in the region 1400 to 2200 Å. Improvements in reflective coatings and better thermal stability resulted in an increase in both the number and quality of profiles recorded. Microdensitometer traces for 37 emission lines are presented. Analysis of the profiles leads to a non-thermal mechanical velocity component which increases with temperature over the range $6.10^3$ to $10^5$ K, always remaining subsonic. Interpretations are considered in terms of a progressive mechanical energy flux to the corona. These include acoustic and MHD modes for both spherically symmetric and network models of the atmosphere. Neither mode can be eliminated, although there are some difficulties in fitting the observations. It is also possible that the observed broadening is caused by non-propagating modes. (auth)

**29129** OBSERVATIONS OF HYDROGEN AND HELIUM ISOTOPES IN SOLAR COSMIC RAYS. Hurford, G. J. Pasadena, CA; California Inst. of Tech. (1975). 134p. University Microfilms Order No. 75-12,515.

Thesis (Ph. D.).

The isotopic compositon of hydrogen and helium in solar cosmic rays provides a means of studying solar flare particle acceleration mechanisms since the enhanced relative abundance of rare isotopes, such as $^2H$, $^3H$, and $^3He$, is due to their production by inelastic nuclear collisions in the solar atmosphere during the flare. In this work the Caltech Electron/Isotope Spectrometer on the IMP-7 spacecraft has been used to measure this isotopic composition. The response of the dE/dx-E particle telescope is discussed and alpha particle channeling in thin detectors is identified as an important background source affecting measurement of low values of ($^3He/^4He$). (Diss. Abstr. Int., B)

**29130** QUIET AND ACTIVE SOLAR EMISSION OF Fe XV 284 A RADIATION Allen, C. W. (Australian National Univ., Canberra). Mon. Not. R. Astron. Soc.; 172: No. 1, 159-173 (Jul 1975).

Intensity contours of 284 Å radiation from the OSO-7 EUV spectroheliograph observations have been analyzed to segregate emissions from the Quiet Sun (Q) and Active Regions (AR) during the period 1972 May to 1974 March. Results are expressed in absolute units using constants from the Goddard Space Flight Center. Measurements include: central, equatorial limb and polar intensities; also Q, AR and total fluxes. Both Q and AR fluxes vary almost in proportion to sunspot number. The Q intensity fits an exponential emission model with scale-height of 0.125 solar radii. Fluxes from individual ARs are closely related to plage-flux data and the relation does not change through the life of the plage. Constants representing the variation of 284 Å emission with the solar cycle have been determined and compared with previous estimates. The absolute emission of the quiet corona has been compared with expected values based on solar eclipse electron densities. The comparison allows an estimate of the coronal irregularity factor x which varies from 4 near the surface to 30 at 1.5 solar radii. Coronal densities within well-developed ARs are about five times the Q value. (auth)

**29131** SEASONAL VARIATION AND MAGNITUDE OF THE SOLAR SECTOR STRUCTURE-ATMOSPHERIC VORTICITY EFFECT. Wilcox, J. M.; Svalgaard, L.; Scherrer, P. H. (Stanford Univ., CA). Nature (London); 255: No. 5509, 539-540(12 Jun 1975).

It is stated that the "solar sector structure" is a large scale property of the Sun seen readily in its magnetic field, which typically consists of four sectors within a 27-day synodic solar rotation period, and within each sector the magnetic field is predominantly either towards or away from the Sun. The sectors are separated by thin current sheets that reverse the direction of the field and constitute sector boundaries. A relationship between the solar sector structure, as swept past the Earth by the solar wind, and terrestrial atmospheric vorticity has been reported, and evidence of a seasonal variation of the effect is reported. (UK)

**29132** SEMI-EMPIRICAL OSCILLATOR FORCES FOR Ti II AND THEIR APPLICATION TO THE STUDY OF SOLAR PHOTOSPHERIC SPECTRA. Biemont, E. (Univ., Liege). Bull. Cl. Sci., Acad. R. Belg.; 60: 1070-1087(1974). (In French).

The Scaled Thomas-Fermi (STF) method is used to calculate absolute oscillator strengths for selected lines of Ti II. The results are compared with previous experimental or theoretical data. On the basis of our gf-values, it is possible to deduce a value for the solar photospheric abundance of Titanium, ($A_{Ti}$ = 4.87) in agreement with a result previously obtained from Ti I lines. (auth)

**29133** INVESTIGATION OF MATERIAL MOTIONS IN A SUNSPOT. Lamb, S. A. (Oxford Univ.). Mon. Not. R. Astron. Soc.; 172: No. 1, 205-220(Jul 1975).

Sightline velocity components for material within a sunspot are determined for a grid of positions across the spot using the iron lines Fe I λ 6302.499 Å, Fe I λ 6270.231 Å and Fe II λ 6247.562 Å. Assuming that the sunspot velocity field has axial symmetry about the spot center it is possible to reconstruct all three components of the velocity from the sightline component. At the center of the umbra a downward velocity of a few tenths of a kilometer per second is found but there is no strong evidence for downward velocities over the rest of the sunspot area. As well as the usual radial outflow in the penumbra (the Evershed effect) a smaller outflow is found in the umbra which rises from zero at the spot center to a maximum of a few tenths of a kilometer per second and then it falls back to zero at the umbral boundary. Azimuthal components of the velocity are found in both the umbra and penumbra, the sense of rotation being opposite in the two, anticlockwise in the umbra with a maximum of a few tenths of a kilometer per second and clockwise in the penumbra with a maximum of between 1.5 and 2.0 km $s^{-1}$. The velocity fields in both Fe I and Fe II are similar indicating that both are formed in the sunspot. A discussion of the results leads to the conclusion that a hydromagnetic wave interpretation may be more promising than an interpretation in terms of streaming motions. (auth)

**29134** NEW LOOK AT THE SUN. Wild, J. P. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). pp 3-19 of Highlights of Astronomy. Epping, Australia; IAU (1974).

A radioheliograph is used to produce moving pictures of the sun in the meter wavelength part of the radio spectrum. The outer corona is studied at a frequency of 80 MHz. Coronal observations are related to what is seen optically in the photosphere and chromosphere. The flash phase and the blast wave of a solar flare are described. A third phase to the solar flare is postulated. (BJG)

**29135** STUDIES ON SOME ASPECTS OF ENHANCED SOLAR MICROWAVE RADIATION. Das Gupta, M. K.; Sarkar, S. K. (Center of Advanced Study in Radio Physics and Electronics, Calcutta). Indian J. Radio Space Phys.; 2: 196-198(Sep 1973).

From symposium on aeronomy and radio wave propagation; New Delhi, India (14 Feb 1973).

Data on disturbed sun emission at different microwave frequencies observed at Sagamore Hill Solar Radio Observatory for a period of about 4 years have been examined in relation to their occurrences, peak flux values, energy excesses and spectral distributions. Important results obtained from the statistical analyses are: spectrum of the average S-component shows a maximum at 4,995 MHz and is independent of the phase of the 27-day cycle, occurrences of both the "simple" bursts ("simple impulsive" and "gradual rise and fall") are maximum at 4,995 MHz, and spectra of majority of the "inverted U" type of microwave bursts have the peak at 4,995 MHz. The analysis suggests that for the study of solar terrestrial phenomena the solar flux observation at 4,995 MHz would serve as a better index instead of at 2,800 MHz assumed till now to be a reliable index. (auth)

**29136** SOLAR MAGNETIC FIELDS AND CONVECTION. II. Magnetic Diffusivity and Flux Concentration. Piddington, J. H. (National Measurement Lab., Sydney (Australia)). Astrophys. Space Sci.; 35: No. 2, 269-283(Jul 1975).

The traditional model of solar magnetic fields is based on convection which dominates generally weak, diffuse fields and so tends to create increasingly tangled fields. Surplus fields must be eliminated by merging of opposite polarities; for example a solar dynamo of period ~10 yr requires fields to be reduced to a scale of <100 km or diffusivity to be increased by a factor of $\sim 10^7$ over molecular diffusivity. It is now shown that the true requirements of any diffuse-field theory are far more stringent, and that surplus fields must be eliminated within a single eddy period of 1 day (10 min) for the supergranules (granules). The reason is that during that period fresh fields are created with flux and energy comparable with those of the old fields. The numerical models of Weiss and Moss are used to confirm this result which is fatal to all diffuse-field theories. The basic error in these theories is found in the assumption that because heat and other passive properties of a fluid diffuse much faster in the presence of turbulence, passive magnetic fields should do likewise. The error is that the heat content of an eddy is not increased by the motion while the magnetic flux and energy are increased rapidly. It is shown that the observed concentrations of surface fields into strengths of $\gtrsim 1000$ G cannot be accounted for by observed surface motions. Nor are they accounted for by the numerical models of turbulence of Weiss or Moss whatever values of the magnetic Reynolds number are assumed. A detailed comparison is made between both small-scale and large-scale surface magnetic features and the predictions of the diffuse-field theory. The differences appear irreconcilable and the features only explicable in terms of the twisted flux-rope model. (auth)

# Galaxies

*Refer also to abstracts 28996, 29052, and 29082.*

**29137** MOLECULES IN ASTROPHYSICS. Winnewisser, G. (Max-Planck-Institut fuer Radioastronomie, Bonn (F. R. Germany)). pp 529-568 of Computational Techniques in Quantum Chemistry and Molecular Physics. Diercksen, G. H. F. (ed.). Dordrecht, Netherlands; Reidel(1975).

From computational techniques in quantum chemistry and molecular physics; Ramsau, Germany (4 Sep 1974). 53 refs.

A short outline is given of how to derive from microwave molecular spectra information about the molecules. Certain aspects of interstellar molecular spectroscopy are discussed such as the distribution of molecules in various interstellar sources and the physical parameters of some clouds as derived from the observed interstellar molecular spectra. (auth)

**29138** STRUCTURE OF THE HI, HII, MOLECULAR AND DUST COMPLEX OF M17. Meaburn, J. (Manchester Univ. (UK)). Astrophys. Space Sci.; 35: No. 1, L5-L8(Jun 1975).

Elliott and Meaburn (1975) have recently carried out the most comprehensive survey yet undertaken of the unusual motions that are occurring in the visible part of the H II region of M17 (NGC 6618). They identified a large area of the nebula where the [O III] 5007 line had up to four components. In a few individual profiles these occurred from −50 $kms^{-1}$ to +10 $kms^{-1}$ compared to the mean position of the [O III] line for this nebula. A model of the whole complex was constructed which attempted to explain these motions by flows from ionization fronts. In this model the exciting stars were heavily obscured by masses of neutral material. Further relationships will now be considered that allow a yet more realistic model to be constructed. (auth)

**29139** TWO BASIC COMPONENTS OF THE INTERSTELLAR NEUTRAL HYDROGEN AND ITS RELATION WITH THE GALACTIC STRUCTURE. Quiroga, R. J. (Instituto Argentino de Radioastronomia, Buenos Aires). Astrophys. Space Sci.; 35: No. 1, 67-80(Jun 1975).

The two basic components of the neutral hydrogen, cool dense clouds merged in a hotter tenuous medium, are studied using 21 cm absorption data of the Parkes Survey. The mean parameters obtained for the typical clouds next to the galactic plane are $\tau_p = 1.7$, velocity half width = 3.3 km $s^{-1}$. Their temperatures are $T_{sc} \geq 40$ K with a mean $T_{sc} = 63 \pm 12$ K and the obtained hot gas density is $n_{HH} = (0.15 \pm 0.05)$ atom $cm^{-3}$. Theoretical analysis following Giovanelli and Brown (1973) reveals that the pressure equilibrium condition $(n_{HH} + 2n_e) \cdot T_{SH} \sim n_{HC} \cdot T_{sc}$ is compatible with the quoted values if it is assumed that the cosmic abundances in the interstellar medium are below the adopted normal solar abundance. This lack of heavy elements suggests accretion to grains which is consistent with the observed narrow concentration of the dark matter on the galactic layer (≤ 100 pc halfwidth). The same pressure condition leads to a mean cool cloud density of $n_{HC} \sim 30$ atom $cm^{-3}$ and a hot gas temperature of $T_{SH} \sim 10\,500$ K. Comparison with data from H II regions suggests that the cool clouds are somewhat denser and less extensive than such regions. An explanation for it is the expansion that the H II regions went through in their origin. Comparison with 21 cm emission data shows that the cloud galactic layer is only about a quarter as thick as the hot gas layer. All the present results suggest that only such clouds can be spatially related with the typical I population associated with the spiral structure. (auth)

**29140** SURVEY OF THE UNUSUAL MOTIONS IN M17 WITH A FABRY-PEROT MONOCHROMATOR. Elliot, K. H.; Meaburn, J. (Manchester Univ. (UK)). Astrophys. Space Sci.; 35: No. 1, 81-96(Jun 1975).

The results of the most extensive survey ever undertaken

of the profiles of the 0[III] line over M17 are presented. These were obtained with an optically-contacted, pressure-scanned, single-etalon Fabry-Perot monochromator used on the 74-in. Radcliffe reflector. Some very unusual velocity features have been revealed. Several regions were found to be emitting lines split by motions of 20 km $s^{-1}$ whereas others produce lines with three or more separate velocity components which stretch up to −70 km $s^{-1}$ from the mean radial velocity of the nebula. Some speculative explanations for these motions are offered. (auth)

**29141** PRESENCE OF PHYLLOSILICATE MINERALS IN THE INTERSTELLAR GRAINS. Zaikowski, A.; Knacke, R. F.; Porco, C. C. (State Univ. of New York, Stony Brook (USA). Dept. of Earth and Space Sciences). Astrophys. Space Sci.; 35: No. 1, 97-115(Jun 1975).

The composition of the interstellar silicate dust is investigated. Condensation or alteration of silicate grains at temperatures of a few hundred degrees, in the presence of $H_2O$, would result in hydrous or phyllosilicates, the silicate type most abundant in the type I carbonaceous chondrites. Infrared spectra of small particles (~0.1μ) of the high temperature condensates, olivine and pyroxene, at 300 K and 4 K do not give a good match to the interstellar absorption band near 9.8 μ. Laboratory spectra of several phyllosilicates give better agreement as does the spectrum of a carbonaceous chondrite. It is proposed that the silicates in the interstellar grains are predominantly phyllosilicates and suggest additional spectral tests for this hypothesis. (auth)

**29142** FORMATION AND DYNAMICS OF GALAXIES: PROCEEDINGS OF THE SYMPOSIUM, CANBERRA, AUSTRALIA, AUGUST 12−15, 1973. Shakeshaft, J. R. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Co. (1974). 454p. $54.40.

Theoretical works and some interpretations based on observational evidence are developed concerning the formation and development of galaxies in terms of their structure, dynamics, and statistical properties. Some of the topics covered include dynamics of superclusters as the most powerful test for theories of galaxy formation, recent Westerbork observations of head-tail galaxies, the distribution of mass-to-light ratio with radius in M31 and M33, dynamics of rotating stellar systems: collapse and violet relaxation, observational evidence for nonvelocity redshift in Stephan's quintet, gravitational interactions between galaxies, and the strength of the galactic shock wave and the degree of development of spiral structure. (IAA)

**29143** EARLY HISTORY OF OUR GALAXY: DYNAMICS. Freeman, K. C. (Mt. Stromlo and Siding Spring Observatories, Canberra, Australia). pp 129-137 of Formation and Dynamics of Galaxies. Shakeshaft, J. R. Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on formation and dynamics of galaxies; Canberra, Australia (12 Aug 1973).

Dynamical aspects of the early history of our galaxy are discussed, with emphasis on the two-component nature of disk galaxies. Topics include the Eggen, Lynden-Bell and Sandage picture of the galaxy's collapse, dynamical problems of the disk, and the bulge component. (auth)

**29144** INTERGALACTIC MATTER AND RADIATION AND ITS BEARING ON GALAXY FORMATION AND EVOLUTION. Burbidge, G. R. (Univ. of California, La Jolla). pp 93-108 of Formation and Dynamics of Galaxies. Shakeshaft, J. R. Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on formation and dynamics of galaxies; Canberra, Australia (12 Aug 1973).

An up-dated review is given of the evidence for the presence of intergalactic matter and radiation in the universe. It is concluded that the only important constituents which may make a sizable contribution to the total mass-energy are intergalactic gas and condensed objects with a very high mass-to-light ratio. If the QSOs are not at cosmological distances, cold atomic hydrogen may still be the most important constituent and may contribute much more mass than do the galaxies. The X-ray observations still do not unambiguously show that very hot gas is present, though it is very likely on general grounds that some hot gas is present in clusters of galaxies. The question of whether or not large amounts of matter, enough to close the universe, are present, remains unsettled. From the theoretical standpoint the answer depends almost completely on the approach taken to the problem of galaxy formation and to the cosmological model which is favored. (auth)

**29145** NEUTRAL HYDROGEN AT LARGE DISTANCES FROM PARENT GALAXIES. Davies, R. D. (Victoria Univ., Jodrell Bank, Eng.). pp 119-128 of Formation and Dynamics of Galaxies. Shakeshaft, J. R. Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on formation and dynamics of galaxies; Canberra, Australia (12 Aug 1973).

High-sensitivity measurements in the vicinity of nearby galaxies have shown the existence of appreciable quantities of neutral hydrogen at large distances (2 to 5 Holmberg radii) from the center. The galaxies studied were the M81/M82/NGC 3077 system, M31, M33, IC 342 and M51. In all cases the gas is at velocities consistent with being bound to the parent galaxy. Of these the M81 system contains the most circum-galactic neutral hydrogen. In several galaxies there is as much neutral hydrogen outside the Holmberg dimensions as inside. (auth)

**29146** EARLY HISTORY OF OUR GALAXY: CHEMICAL EVOLUTION. Peimbert, M. (Universidad Nacional Autonoma de Mexico, Mexico City). pp 141-156 of Formation and Dynamics of Galaxies. Shakeshaft, J. R. Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on formation and dynamics of galaxies; Canberra, Australia (12 Aug 1973).

A general review is given of chemical abundance determinations; particular emphasis is given to abundances of galactic and extragalactic metal-poor objects, since presumably they represent the abundances of the primeval material from which our galaxy was formed. The following results are stressed: most of the helium present in the galaxies of the local group as well as in other galaxies was produced before these objects were formed; the heavy elements were produced mainly as the result of stellar evolution; there is a chemical abundance gradient in our galaxy and, by analogy with other galaxies, it is expected to be steeper near the nucleus; the carbon and oxygen content of our galaxy increased at a rate different from the metals, reaching their present abundance earlier than the other heavy elements; and the increase of the iron abundance in the disk of our galaxy with time has been small, while that of carbon is negligible; furthermore, as a group, the super-metal-rich stars correspond to the old disk population. Several models of galactic chemical evolution are reviewed. (auth)

**29147** DYNAMICS OF SUPERCLUSTERS AS THE MOST POWERFUL TEST FOR THEORIES OF GALAXY FORMATION. Ozernoi, L. M. (Inst. of Physics, Moscow). pp 85-91 of Formation and Dynamics of Galaxies. Shakeshaft, J. R. Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on formation and dynamics of galaxies; Canberra, Australia (12 Aug 1973).

Analysis of Brown's (1964, 1968) data on the orientation of galaxies inside superclusters confirms his conclusion that the directions of the major axes of the galaxies are significantly correlated. For a number of superclusters, the minor axes are found to be oriented along the direction of the flattening of the supercluster as a whole. By analogy with the Local Supercluster where the same phenomenon is associated presumably with the rotation established by de Vaucouleurs (1959), one may conclude that, in general, superclusters rotate. It is shown that rotation on scales as large as these cannot be explained by tidal or by any local effects, and must have a primeval nature analogous to the 3 K microwave background. Rotation on such scales contradicts the standard idea of galaxy formation from density fluctuations but favors the concept of primeval whirls which gave rise to pregalactic density inhomogeneities. (auth)

**29148** DISTRIBUTION OF GALAXIES IN RELATION TO THEIR FORMATION AND EVOLUTION. Peterson, B. A. (Mt. Stromlo and Siding Spring Observatories, Canberra, Australia). pp 75-84 of Formation and Dynamics of Galaxies. Shakeshaft, J. R. Dordrecht, Netherlands; D. Reidel Publishing Co. (1974).

From conference on formation and dynamics of galaxies; Canberra, Australia (12 Aug 1973).

The distribution of galaxies on the sky is not random, but has structure on a scale of about 30 Mpc. Similar structure in the cosmic background radiation is not present. Another expected source of structure in the background radiation is the finite size of the light horizon in the early universe. The lack of observable structure in the background radiation implies extreme initial isotropy. Quantum effects may be responsible for this isotropy, and for the initial perturbations from which galaxies and clusters of galaxies formed. (auth)

**29149** NEUTRAL HYDROGEN IN THE GALACTIC CENTER REGION. I. The Observations. Cohen, R. J. (Nuffield Radio Astronomy Lab., Jodrell Bank, Eng.). Mon. Not. R. Astron. Soc.; 171: No. 3, 659-696(Jun 1975).

A survey of the 21-cm line of neutral hydrogen has been made at Jodrell Bank with the Mark II radio telescope (beam-width 31′ × 35′) and the Mark I A radio telescope (beam-width 13′ × 13′), covering the region $355° \le l \le 10°$, $-5° \le b \le 5°$, and the velocity range −530 km $s^{-1}$ to +530 km $s^{-1}$. The velocity resolution was 7.3

km $s^{-1}$, and the rms noise level typically 0.1 K. The data are presented in the form of contour maps of antenna temperature as a function of galactic latitude and velocity, and also as a function of galactic longitude and velocity. Six new high-velocity emission features have been detected, all lying out of the galactic plane. All the high-velocity features seen in the survey are described. (auth)

**29150** G0.55-0.85, AN H II REGION-MOLECULAR CLOUD COMPLEX. Gardner, F. F.; Whiteoak, J. B. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Mon. Not. R. Astron. Soc.; 171: No. 3, 29P-31P(Jun 1975).

OH, $H_2CO$ and H 110 $\alpha$ lines have been observed in the direction of G0.55−0.85, an H II region identified with RCW 142. Optical depths in the satellite lines of OH at 1720 and 1612 MHz are unusually high—both are in absorption with about equal intensity, a central velocity of 16.8 km $s^{-1}$, and a half-width of 4.7 km $s^{-1}$. On the other hand, the OH main lines are dominated by a number of narrow emission lines with radial velocities between 6 and 19 km $s^{-1}$. The results are interpreted in terms of a Class I OH source embedded in a dense molecular cloud, probably no more distant than the Sagittarius arm. (auth)

**29151** STUDY OF THE NEUTRAL HYDROGEN NEAR THE INTERACTING GALAXIES NGC 4631 AND NGC 4656. Winter, A. J. B. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 1-11(Jul 1975).

High-resolution 21-cm maps of the pair of interacting galaxies NGC 4631/ NGC 4656 have been made with the Half-Mile telescope at Cambridge. Large amounts of neutral hydrogen are found at distances up to 12 kpc above the plane of NGC 4631, together with complex structure in the bridge joining the two galaxies. The bearing of these results on the nature of the interaction is discussed. (auth)

**29152** FRAGMENTATION IN A COLLAPSING GAS CLOUD. Smith, R. C.; Wright, A. E. (Sussex Univ., Brighton, Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 221-225(Jul 1975).

The conditions are discussed under which fragmentation in a collapsing gas cloud stops when the cloud ceases to be isothermal, and an argument is presented which suggests that these conditions hold in practice. (auth)

**29153** METAL ABUNDANCES IN NEARBY STARS AND THE CHEMICAL HISTORY OF THE SOLAR NEIGHBORHOOD. Pagel, B. E. J.; Patchett, B. E. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Not. R. Astron. Soc.; 172: No. 1, 13-40 (Jul 1975).

A simple theory of galactic enrichment in heavy elements is described in some detail, for the purpose of indicating clearly how the assumptions in numerical models of galactic evolution are related to the observational constraints imposed by the dependence of stellar chemical composition on time of formation and by the statistical distribution of metal abundances in long-lived stars such as the G dwarfs. Observational data bearing on these two questions are reviewed and the cumulative distribution of metal abundances in G dwarfs is derived from an analysis of photometric data in catalogues of nearby stars. Simple models of galactic evolution do not fit the distribution function of metal abundance because they predict too many metal-deficient stars. Modifications of the simple model that give a satisfactory fit include prompt initial enrichment (PIE) and the early version of metal-enhanced star formation (MESF(1)); a particularly successful version of PIE is that one of the series of two-component disk-halo models of Ostriker & Thuan which assumes that 10 per cent of the mass of the disk is secondary material from the halo. The more sophisticated MESF(2) model of Talbot does not fit so well as PIE or MESF(1). Inhomogeneous collapse and infall models only fit the data if they are combined with PIE or MESF(1) and if the present rate of infall is not too large; such processes acting mainly in a short initial phase could, however, lead to a successful model effectively incorporating PIE. (auth)

**29154** A CLASSIFICATION OF THE AVAILABLE ASTROPHYSICAL DATA OF PARTICULAR H II REGIONS. I. Orion Nebula: Optical, Radio, Infrared and Molecular Mapping. Goudis, C. (Manchester Univ. (UK)). Astrophys. Space Sci.; 35: No. 2, 409-458(Jul 1975).

The available optical, radio, infrared and molecular contour maps of the object are presented. Velocity distribution contour maps are also included. Analytical information for each map is classified in separate tables. (auth)

**29155** ON THE STABILITY OF GALACTIC SHOCKS. Mishurov, Yu. N.; Suchkov, A. A. (Rostovskij-na-Donu Gosudarstvennyj Univ. (USSR)). Astrophys. Space Sci.; 35: No. 2, 285-297(Jul 1975).

The stability of galactic spiral shocks is considered. A steady-state shock should be checked to see if it is evolutionary; if its front is stable against bending and torsion; and if the gas flow far from the front is stable. In the present paper the evolutionary criterion is obtained, which implies that conditions in galaxies may lead to the evolutionary spiral shocks as well as to the non-evolutionary ones. In the latter case a galactic shock cannot persist, it instantly decays, emitting spontaneously spiral waves. This leads to a plausible stratification of the spiral arms, to the formation of the secondary arms, "spurs" and other secondary features. The steady-state gas flow with a galactic shock (Roberts, 1969) turns out to be unstable far from the shock front, the increment being proportional to the velocity gradient. For the spiral shock calculated by Roberts (1969) the instability develops ahead of the shock front with the same growth-time of about $3 \times 10^7$ years for all disturbance scales. This may provide a mechanism to generate turbulence of interstellar gas and to form the patchy structure of spiral arms which are known to include the structural units (gas clouds) on all possible scales. (auth)

**29156** STELLAR WINDS AND GLOBULES IN H II REGIONS. Dyson, J. E. (Manchester Univ. (UK)). Astrophys. Space Sci.; 35: No. 2, 299-312(Jul 1975).

The interaction of a plane-parallel hypersonic stellar wind with a globule in an H II region is considered in two approximations. In both approximations, the ionization front on the globule remains strong-D type, and a flow pattern containing two oppositely facing shock waves results. In the first approximation, the structure of the shocked region is calculated assuming that globule gas and stellar wind gas mix well and move at the same velocity. However, this assumption results in a very thick shocked layer and the assumption of good mixing is consequently not well justified. This approximation provides an upper limit on the gas velocities expected in the shocked gas which originated at the globule. In the second approximation, the stellar wind merely applies pressure to balance the momentum flux in the globule gas. The structure of the shocked region is calculated on the assumption that a tangential discontinuity exists between shocked stellar wind and shocked globule gas. Structures may be produced having velocities ~10 km $s^{-1}$ and emission measures ~$10^3$ $cm^{-6}$ pc with reasonable stellar luminosities and mass loss rates. (auth)

## Cosmology

**29157** EXCITATION AND DETECTION OF STANDING GRAVITATIONAL WAVES. Grishchuk, L. P.; Sazhin, M. V. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1569-1582(May 1975). (In Russian).

A concrete scheme of an experiment for the emission and detection of gravitational waves under laboratory conditions is considered. The arrangement contains both a source and receiver of the radiation. The gravitational wave source is a torus-shape electromagnetic cavity in which a varying electromagnetic field is excited. Interference of the emitted gravitational waves results in a pattern of a standing cylindrical wave in the focal region of the source, near its symmetry axis. The detector, an electromagnetic cavity in which a certain initial electromagnetic field is set up, is arranged in the focal region. As a result of interaction with the gravitational wave an additional electromagnetic field appears in the detector and this field can be observed. A formula relating the emitter and detector parameter is derived for the limiting case when the detector is located at the boundary of the wave zone of the emitter. The formula is deduced under the condition that the signal-to-noise ratio for the detector is unity. Preliminary estimates show that the creation of a system with a set of parameters required for performing the experiment is a very difficult technical problem which, however, can probably be solved. (auth)

**29158** MECHANISMS FOR THE EMISSION AND ABSORPTION OF GRAVITATIONAL RADIATION. Misner, C. W. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). pp 3-15 of Gravitational Radiation and Gravitational Collapse. Dewitt−Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

Following some introductory comments on the fundamentals or first principles governing jointly the emission and absorption of gravitational waves, a list is given of observational targets or goals for gravitational wave astronomy which have been selected from recent critical reviews. Then theoretical studies of plunge radiation and gravitational synchrotron radiation are surveyed, since in this area new techniques are developing rapidly although new observational prospects have not yet been found. (auth)

**29159** DETECTION OF GRAVITATIONAL RADIATION. Tyson, J. A. (Bell Telephone Labs., Inc., Murray Hill, N. J. (USA)). pp 17-27 of Gravitational Radiation and Graviational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

The claims by J. Weber must be examined in the context of system time-response and signal-to-noise ratio. After briefly discussing the sources and spectral distribution of system noise, optimal time-domain filtering is discussed. Although five independent groups have searched for two-antenna coincidences, only Weber has claimed any excess at zero time lag. Preliminary results of a high sensitivity two-antenna coincidence search are presented. (auth)

**29160** PROSPECTS FOR HIGH SENSITIVITY GRAVITATIONAL ANTENNAE. Braginskii, V. B. (Moskovskij Gosudarstvennyj Univ. (USSR). Fizicheskij Fakul'tet). pp 28-34 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

The sensitivity of a resonant gravitational wave detector which is necessary for the detection of pulses from asymmetric stellar collapses or from blackhole collisions in nearby galaxies is examined. Limitations on this sensitivity due to the resonating quality of the detector, thermal noise, and reaction of the detection system upon the detector are studied. No severe difficulties for the detection of the above-mentioned pulses are expected. For the detection of pulses from a cluster at the galactic center, a nonresonant system based on Doppler ranging to a drag-free satellite would be more appropriate. At present the sensitivity of Doppler-ranging is still two orders of magnitude below the requirements. (auth)

**29161** USE OF CRYOGENIC TECHNIQUES TO ACHIEVE HIGH SENSITIVITY IN GRAVITATIONAL WAVE DETECTORS. Boughn, S. P.; Fairbank, W. M.; McAshan, M. S.; Paik, H. J.; Taber, R. C. (Stanford Univ., Calif. (USA). Dept. of Physics); Bernat, T. P.; Blair, D. G.; Hamilton, W. O. (Louisiana State Univ., Baton Rouge (USA). Dept. of Physics and Astronomy). pp 40-51 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

Cryogenic detectors for gravitational wave astronomy promise greatly improved sensitivity over room temperature detectors. The 3 mK detector under construction should give an improvement of $10^6$ over existing detectors. The cryogenic antennae are described and the calculated low temperature performance is detailed. New superconducting instrumentation is described. (auth)

**29162** ELECTROMAGNETIC DETECTORS OF GRAVITATIONAL WAVES. Braginskii, V. B.; Grishchuk, L. P.; Doroshkievich, A. G.; Zel'dovich, Ya. B.; Novikov, I. D.; Sazhin, M. V. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). pp 54-58 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

The most promising approach to detection and laboratory generation of high frequency gravitational waves (GW) seems to be through the transformation of GW into electromagnetic waves (EMW), and the reverse process: EMW → GW. The effects are small of course. The generation, EMW → GW, depends on the gravitational effect of the density of electromagnetic energy, which is equal to $(E^2 + B^2)/8\pi c^2$ and is of order $10^{-12}$ g cm$^{-3}$ for $B = 10^5$G. The detection depends on h—the GW perturbations of the metric. To obtain $h = 1$ one needs an energy flux $W = c^3/G = 10^{59}$ erg s$^{-1}$. On the other hand, there are factors which multiply the effect and inspire some hope. They are the resonance and coherence of waves. Although on final answer is given, the situation (ignoring technical difficulties) seems better than it did some years ago. (auth)

**29163** STABILITY OF RELATIVISTIC SYSTEMS. Chandrasekhar, S. (Chicago Univ., Ill. (USA). pp 63-81 of Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

The stability of relativistic systems is reviewed against the background of what is known in the corresponding contexts of the Newtonian theory. In particular, the importance of determining whether Dedekine-like points of bifurcation occur along given stationary axisymmetric sequences is emphasized: the occurrence of such points of bifurcation may signal the onset of secular instability induced by radiation-reaction. (At a Dedekind-like point of bifurcation, the system can be subject, quasistationarily, to a non-axisymmetric deformation with an $e^{2i\phi}$ -dependence on the azimuthal angle $\phi$.) A formalism is described in terms of which the normal modes of axisymmetric oscillation of axisymmetric systems can be determined. Specialized to neutral modes of oscillation the formalism provides an alternative proof of Carter's theorem and clarifies the minimal requirements for its validity. A parallel formalism is described for ascertaining whether an axisymmetric system can be subject to a quasi-stationary non-axisymmetric deformation. The possibility of applying this latter formalism to determining whether a Dedekind-like point of bifurcation occurs along the Kerr sequence is considered. (auth)

**29164** GRAVITATIONAL COLLAPSE. Penrose, R. (Oxford Univ.(UK)). pp 82-91 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

In the standard picture of gravitational collapse to a black hole, a key role is played by the hypothesis of cosmic censorship—according to which no naked space-time singularities can result from any collapse. A precise definition of a naked singularity is given here which leads to a strong "local" version of the cosmic censorship hypothesis. This is equivalent to the proposition that a Cauchy hypersurface exists for the space-time. The principle that the surface area of a black hole can never decrease with time is presented in a new and simplified form which generalizes the earlier statements. A discussion of the relevance of recent work to the naked singularity problem is also given. (auth)

**29165** BLACK AND WHITE HOLES. Markov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). pp 106-131 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

Various possible cases of spherical systems, the matter of which is localized in a domain smaller than the corresponding gravitational radius are considered. The metric of the Friedmann closed world or of a part of it with an external continuation is suggested as a model of these systems. There can exist black holes which are described by semi-closed metrics (black holes of the second kind). The class of systems in question may be both in the state of collapse and in the state of anti-collapse (including the state of "white holes"). The notion of black holes may turn out to be essential in elementary particle theory: among the intermediate states in elementary particle theory there are states the characteristic feature of which is the localization of arbitrary large energies (masses) in a domain smaller than the gravitational radius. (auth)

**29166** PROPERTIES OF BLACK HOLES RELEVANT TO THEIR OBSERVATION. Bardeen, J. M. (Yale Univ., New Haven, Conn. (USA)). pp 132-144 of Gravitational Radiation and Gravitational Collapse. Dewitt-Morette, C. (ed.). Dordrecht, The Netherlands; Reidel (1974).

From symposium on gravitational radiation and gravitational collapse; Warsaw, Poland (5 Sep 1973).

Black holes are very small objects by astronomical standards, so in many circumstances they interact with their surroundings like a Newtonian mass point. However, if black holes are present in X-ray binary systems, the X-rays emitted in the inner part of the accretion disk probe the highly curved spacetime geometry near the horizon, particularly if the black hole is rapidly rotating. Some of the properties of circular orbits near the black hole are quite sensitive to the amount of angular momentum. The relativistic corrections remove a Newtonian degeneracy between several of the characteristic frequencies associated with perturbations of the circular orbits. Hot spots in the inner part of the disk can produce dramatic fluctuations in intensity, since the frequency shifts of photons emitted by a given point on the disk are strongly time-dependent. The bending of the photon trajectories by the strong gravitational field can drastically affect the energy balance of the disk; much of the radiation emitted by the inner part of the disk is reabsorbed. The dragging of inertial frames by the angular momentum of the black hole can have striking consequences for the structure of the disk at quite large radii if the angular momentum of the accreting matter is not in the same direction as the angular momentum of the black hole. Dynamic perturbations of black holes are now being intensively

studied to see if there are any surprising physical effects associated with the rotation of the black hole. Unfortunately, though quite interesting methods of extracting energy from the black hole exist in principle most of them are unlikely to be realized to an important extent in the real astrophysical world. (auth)

**29167** MACH'S PRINCIPLE IN COSMOLOGY. Ihrig, E. (New Brunswick Univ., Fredericton, Canada). Int. J. Theor. Phys.; 12: No. 6, 401-405(Apr 1975).

In certain class of cosmological models it is shown that every Ricci flat complete space-time must be locally flat. (auth)

**29168** ABSORPTION LINES OF QUASISTELLAR OBJECTS. A Kinematical Description. Alvarez, E.; Gracia-Bondia, J. M. (Universidad Autonoma de Madrid (Spain). Departamento de Fisica Teorica). Astron. Astrophys.; 36: No. 2, 299-303(Nov 1974).

The object is to show that the experimental distribution of absorption redshifts of QSOs is consistent with the assumption that these lines are due to the presence of interlopers physically unrelated to QSOs. Some new formulas for the probability that the light emitted by a QSO is interrupted by an object located by chance in its line of sight were obtained in the framework of the kinetic theory of cosmology (KTC). This allows writing a "correlation function" between absorption and emission redshifts. The first moments of the contractions of this function are compared with observation. Making use of the hypothesis of KTC, it is possible to estimate the mass of interlopers and other typical features, as well as their contribution to the mean mass density in the universe. (auth)

**29169** LOW-DIMENSIONAL HOMOGENEOUS COSMOLOGIES. Saar, E. Publ. Tartu. Astrofiz. Observ.; 42: 180-187(1974). (In Russian).

All general relativistic homogeneous cosmological models with one- and two-dimensional space sections, containing incoherent matter, are described. There are no one-dimensional dust models at all. One-dimensional homogeneous models with unusual equations of state can be constructed, however, but only for a nonzero cosmological constant. On the contrary, one-dimensional homogeneous Newtonian cosmologies do exist. Two-dimensional homogeneous models have space sections of constant curvature. For dust models the temporal behavior of the scale factor does not depend on the curvature, as is the case for usual Friedmann models, but on the cosmological constant only. (auth)

**29170** COOLING OF THE INTERGALACTIC GAS IN FRIEDMANN UNIVERSES. Yaniste, Ya. Publ. Tartu. Astrofiz. Observ.; 42: 188-209(1974). (In Russian).

The thermal evolution of intergalactic matter is studied. Generalized Friedmann cosmological models with radiation are used as the background ones. Formulas for the temperature and degree of ionization of the gas are derived. Results of the numerical calculations on the cooling of the hydrogen-helium gas after the secondary heating are given. The initial temperature at $z = 3$, about $10^6$ °K, appears to be high enough to explain the observed lack of absorption by neutral hydrogen in the spectra of distant quasars. The resulting background of thermal radiation does not contradict observations. The main results of the paper are presented in Figs. 1–4. (auth)

**29171** MACH'S PRINCIPLE IN GENERAL RELATIVITY. Raine, D. J. (Oxford Univ.). Mon. Not. R. Astron. Soc.; 171: No. 3, 507-528(Jun 1975).

Mach's Principle is taken as a criterion for selecting cosmological solutions of the Einstein field equations, in which, in a well-defined manner, the metric arises from material sources alone. In such model universes inertial forces are due to the gravitational interaction of matter, and there is a relativity of accelerated motion. The problem of stating such a selection rule in general relativity divides into two parts: an analysis of the relation of the metric to the Riemann curvature, and of the curvature to the stress tensor, with associated Machian criteria. Mach's Principle is found to be satisfied in Robertson–Walker models and in a simple class of inhomogeneous solutions. These results lead to the suggestion that Mach's Principle may play a role in explaining the observed gross features of the Universe. (auth)

**29172** NOTE ON THE ZELDOVICH p = rho COLD BIG BANG. Liang, E. P. (Univ. of Utah, Salt Lake City). Mon. Not. R. Astron. Soc.; 171: No. 3, 551-553(Jun 1975).

Entropy production in $p = \rho$ cold baryon models is studied in the context of primordial shear damping. Special features of the dynamics of density inhomogeneities in such models are discussed. (auth)

**29173** BLACK HOLES, GRAVITATIONAL WAVES AND COSMOLOGY: AN INTRODUCTION TO CURRENT RESEARCH. Rees, M.; Ruffini, R.; Wheeler, J. A. Topics in Astrophysics and Space Physics, Vol. 10. New York; Gordon and Breach, Science Publishers, Inc. (1974). 182p. $29.50.

The physics of a superdense star are considered along with pulsars, supernovae, quasi-stellar objects, the traditional three tests of relativity, relativistic effects in planetary and lunar motions, the expanding universe, the evolving universe, the significance of the microwave background, questions of galaxy formation, the mystery of the missing mass, the cosmic background radiation, and aspects regarding "noncanonical" models and the very early universe. Topics examined in connection with black holes are related to a collapse of a spherically symmetrical cloud of dust, the Kruskal diagram, rotation and the Kerr geometry, the final outcome of the collapse of a rotating body, and the search for black holes and their effects. The angular distribution of gravitational radiation is discussed together with the sources of gravitational radiation and the seismic response of the earth to the gravitational radiation in the one-Hertz region. (IAA)

## Planetary Phenomena

*Refer also to abstracts 28982, 28983, 29030, 29031, 29096, 29111, 29126, 29173, and 29286.*

**29174** DECELERATION OF FLARE-GENERATED INTERPLANETARY SHOCK WAVES. Pinter, S. (Geophysical Inst., Hurbanova, Czech.). Bull. Astron. Inst. Czech.; 26: No. 3, 169-180(1975).

The propagation of flare-generated shock waves in interplanetary space is studied. Eighteen events with which the passage of a shock wave was observed by two space probes at least, were obtained; the space probes were located at different heliocentric distances. From the known distance of the Sun to the point of observation of the shock wave and from the time difference between the generation and passage of the shock wave through the point of observation, the mean radial velocity of propagation of the flare-generated interplanetary shock was determined. Results prove the strong deceleration nature of the interplanetary shock wave. Under the assumption that the deceleration "d" is linear, the initial velocity of the shock $V_0$ was computed for the individual cases. A linear relation was observed between the radial velocity of the solar coronal shock waves. The large-scale geometric structure of the plane of the ecliptic, proved the spherical, or quasi-spherical geometry of the shock wave front. Spherical, or quasi-spherical geometry is also displayed by coronal shock waves, investigated by means of Culgoora radioheliograms. (auth)

**29175** EARTH AS AN INTENSE PLANETARY RADIO SOURCE: SIMILARITIES TO JUPITER AND SATURN. Kaiser, M. L.; Stone, R. G. (Goddard Space Flight Center, Greenbelt, MD). Science; 189: No. 4199, 285-287(25 Jul 1975).

Observations from spacecraft have revealed naturally occurring radio emission emanating from two regions near Earth. The characteristics of these two sources suggest a correlation with areas of known electron precipitation. The possibility of a similar production mechanism for observed nonthermal radio emissions from other planetary magnetospheres permits the polar magnetic field strengths of Jupiter and Saturn to be predicted. 3 figs, 15 refs. (auth)

**29176** COMMENTS ON THE ROTATION OF THE PLANETS. Horedt, G. (Cluj Univ. (Romania)). Astrophys. Space Sci.; 35: No. 1, L15-L16(Jun 1975).

The isochronism of the rotation of most asteroids and planets (Alfvén and Arrhenius, 1970; Brosche, 1974) is generally attributed to the accretion from grains of these celestial bodies. Ponderomotive braking of rotation as suggested by Icke (1973) could be of some importance only for the subsequent evolution of asteroids. The problem of planetary rotation can be solved only by taking into account the detailed vectorial distribution of angular momentum during accretion. (auth)

**29177** HIGHER HARMONICS OF THE TERRESTRIAL AND LUNAR GRAVITATIONAL FIELDS IN THE THEORY OF THE DYNAMICS OF THE EARTH'S ROTATION AXIS. Bursa, M. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech.; 26: No. 4, 218-234(1975).

Euler's dynamic equations, describing the motion of the Earth's axis of rotation, are derived with the harmonics of the terrestrial and lunar gravitational fields being retained up to the 4th degree. As regards the terrestrial field Stokes's constants $n = 2$; $k = 0$; $n = 2$, $k = 2$; $n = 3$, $k = 0, 1, 2, 3$; $n = 4$, $k = 0$, $n = 4$, $k = 3$; and as regards the lunar field only the constants $n = 2$, $k = 0$; $n = 2$, $k = 2$ will come to bear. (auth)

**29178** EFFECT OF THE THIRD PRODUCT OF INERTIA AND OF EQUATORIAL FLATTENING OF THE EARTH ON THE FREE NUTATION OF THE ROTATIONAL AXIS. Bursa, M. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech.; 26: No. 4, 237-241(1975).

Euler's dynamic equations of the free nutation of the Earth's axis of rotation are solved for the case in which the equatorial moments of inertia differ from one another and the third product of inertia differs from zero. The Lagrange method of variation of arbitrary constants was used in combination with the method of successive approximations. (auth)

**29179** STUDIES OF SOLAR COSMIC RAYS ON THE MARS-7 STATION. Vernov, S. N.; Alekseev, N. V.; Vakulov, P. V. Cosmic Res.; 13: No. 1, 114-117(1975).

Translated from Kosm. Issled.; 13: No. 1, 131-135(1975).

A KM-F3 scientific instrument complex consisting of several instruments having gas-discharge, semiconductor, and Cherenkov detectors was mounted on the Mars-7 station to study solar cosmic rays on the flight route and in the vicinity of Mars. A distinctive feature of the fluxes recorded from the flare of September 7, 1973, was the prolonged negative anisotropy. It is concluded that the principal stream of particles in the flare moved away from the sun to the south of the plane of the solar equator and somewhere in the region of the orbit of Mars or beyond it crossed this plane and began to fill the region to the north of the plane of the solar equator. It is possible that the passage of the magnetic field lines, along which the main crossover of particles occurred, of the southern hemisphere of the solar system to the northern hemisphere takes place in this region. (BJG)

**29180** STUDIES OF SOLAR PLASMA NEAR MARS AND ON EARTH-MARS ROUTE USING CHARGED-PARTICLE TRAPS ON SOVIET SPACECRAFT IN 1971-1973. III. Characteristics of Ion and Electron Components of Plasma in Antisolar Part of Near-Mars Space Measured on Satellite Mars-5. Gringauz, K. I.; Bezrukikh, V. V.; Verigin, M. I.; Remizov, A. P. Cosmic Res.; 13: No. 1, 107-111(1975).

Translated from Kosm. Issled.; 13: No. 1, 123-128(1975).

Characteristics of the ion and electron components of low-energy plasma are measured with wide-angle charged particle traps. Data of new instruments of the position of the boundaries and of the characteristics of the transitional layer behind the front of the near-Mars departing shock wave are given as well as data of the first measurements of the characteristics of a plasma formation located behind the inner boundary of the transitional layer in the antisolar part of near-Mars space. Two hypotheses concerning the nature of the plasma zone are discussed. (BJG)

**29181** INITIAL RESULTS OF ION FLUX MEASUREMENTS BY THE RIEP-2801 M INSTRUMENT ON MARS-4 AND MARS-5. Vaisberg, O. L.; Bogdanov, A. V.; Smirnov, V. N.; Romanov, S. A. Cosmic Res.; 13: No. 1, 112-113(1975).

Translated from Kosm. Issled.; 13: No. 1, 129-130(1975).

Electrostatic charged-particle analyzers are used to obtain data on ion fluxes in the vicinity of Mars. The existence of a boundary shock wave near Mars is confirmed as well as a zone within a transitional region where strong retardation of the flux of ions and their cooling are observed. Ion spectra characteristics for the boundary layer are observed. Certain characteristics of the energy spectra indicate a possible change in the ion composition in the boundary layer. (BJG)

**29182** MAGNETIC FIELD OF MARS FROM DATA OF MARS-3 AND MARS-5. Dolginov, Sh.Sh.; Eroshenko, E. G.; Zhuzgov, L. N. Cosmic Res.; 13: No. 1, 94-106(1975).

Translated from Kosm. Issled.; 13: No. 1, 108-122(1975).

Magnetograms on Mars-3 identify the changes in the field characteristic for the motion of a space probe in the solar wind, at the intersection of the shock front, in the transition region between the front and the magnetopause, the intersection of the magnetopause, and the region of the maximal field at the pericenter. The experimental data on the strength and topology of the field, the position of the shock front, and the intensity of the solar wind can be explained by the assumption that Mars has an intrinsic magnetic field that is deformed and restricted on the day side by the action of a supersonic particle flux and fields of the solar wind. Measurements at the points nearest to the pericenter are used to determine the dipole magnetic moment and the field strength at the magnetic equator. Models of the intrinsic magnetic are compared with two other models. Conclusions about the nature of the magnetic field observed by the magnetometers are drawn on the basis of plasma experiments. (BJG)

**29183** RADIATION LEVELS IN INTERPLANETARY SPACE FROM DATA OF THE PROGNOZ SATELLITES. Logachev, Yu. I.; Savenko, I. A.; Sladkova, A. I. Cosmic Res.; 12: No. 5, 716-718(1974).

Translated from Kosm. Issled.; 12: No. 5, 789-791(1974).

This report presents the results of radiation dose measurements during the flights of the satellites Prognoz 1 and Prognoz 2 (April-December 1972) in interplanetary space. For the major portion of their flights, the satellites were outside the terrestrial magnetosphere. Radiation doses were measured with a wide-range ionization chamber. The major contribution to the radiation dose is made by protons and helium nuclei. The radiation dose produced by galactic rays during years of maximum solar activity decreases by a factor of more than two. Total galactic cosmic ray dosage over a year does not exceed 5-10 rad. During chromospheric flares the particle flux in interplanetary space can increase by a factor of 1000 or more, which can lead to significant increases in radiation danger. (BJG)

**29184** POSSIBLE METHOD FOR DIAGNOSING PLASMAS IN SPACE. Kovner, A. Sh.; Kovner, M. S. Cosmic Res.; 12: No. 5, 713-715(1974).

Translated from Kosm. Issled.; 12: No. 5, 787-789(1974).

The possible determination of the electron density and the mean free path of plasmas in space is discussed based on measurements of the impedance of an antenna in a spherical cavity surrounded by plasma. A calculation is carried out to find the correction to the impedance due to the plasma environment. Results are presented. (BJG)

**29185** INTENSITY RISES FOR ELECTRONS OF ENERGY $E_e$ GREATER THAN OR EQUAL TO 40 keV DUE TO QUASI-STEADY SOLAR-WIND PLASMA STREAMS. Zel'dovich, M. A.; Kuzhevskii, B. M.; Shestopalov, I. P. Cosmic Res.; 12: No. 5, 661-665(1974).

Translated from Kosm. Issled.; 12: No. 5, 725-730(1974).

The rises in the intensity of electrons at energies $E_e \geq 40$ keV observed on May 22 and July 15 and 18, 1972, are shown to have taken place at the boundary of a quasisteady shock wave corotating with the sun. In each event the particle flux approximately doubled relative to the background, reaching $\approx 3$ particles $\cdot$ cm$^{-2}$ $\cdot$ sec$^{-1}$ $\cdot$ sr$^{-1}$. The May 22 and July 15 rises occurred at the boundary of an interplanetary magnetic-field sector. (auth)

**29186** COMPARISON OF FLUCTUATIONS IN THE SPECTRAL DENSITY DISTRIBUTION OF SOLAR-WIND PROTONS AND $\alpha$ PARTICLES MEASURED WITH THE PROGNOZ SATELLITE. Zertsalov, A. A.; Vaisberg, O. L.; Zastenker, G. N.; Khokhlov, M. Z. Cosmic Res.; 12: No. 5, 653-660(1974).

Translated from Kosm. Issled.; 12: No. 5, 716-724(1974).

Energy spectra of the solar-wind ions $H^+$, $He^{++}$, and $He^+$ have been measured separately with an RIP-803 energy-mass analyzer carried by the high-apogee Prognoz satellite during June-August, 1972. In several sessions the output signals were recorded at high speed (one measurement every 1.28 sec), so that rapid flux variations in different energy ranges could be investigated for each type of ion individually. The amplitude of the fluctuations in the spectral flux density for the $\alpha$ particles was found to vary strongly with time, by an amount several times greater than the proton fluctuations. The value of this amplitude is compared with the conditions prevailing in the interplanetary medium. A substantial rise in the level of fluctuations for $\alpha$ particles evidently takes place some time after the arrival of helium-enriched plasma from a flare. (auth)

**29187** ENERGETIC SOLAR PROTON VS TERRESTRIALLY TRAPPED PROTON FLUXES. King, J. H.; Stassinopoulos, E. G. (Goddard Space Flight Center, Greenbelt, MD). J. Spacecr. Rockets; 12: No. 2, 122-124(Feb 1975).

The relative importance of solar and trapped proton fluxes in the consideration of shielding requirements for 1977-1983 geocentric space missions is discussed. The latest solar proton and trapped proton models are used to compute fluences of these particles encountered by spacecraft in circular orbits as functions of orbital altitude and inclination, mission duration, threshold energy, and, for solar proton fluxes, risk factor. Ratios of solar-to-trapped proton fluences are taken which give the relative importance of the two proton populations and indicate to the mission planner whether he must consider both or only one of these populations. (BJG)

**29188** JUPITER: ITS INFRARED SPECTRUM FROM 16 TO 40 MICROMETERS. Houck, J. R. (Cornell Univ., Ithaca, NY); Pollack, J. B.; Schaack, D.; Reed, R. A.; Summers, A. Science; 189: No. 4204, 720-722(29 Aug 1975).

Spectral measurements of the thermal radiation from Jupiter in the band from 16 to 40 micrometers are analyzed under the assumption that pressure-broadened molecular hydrogen transitions are responsible for the bulk of the infrared opacity over most of this spectral interval. Both the vertical pressure-temperature profile and the molecular hydrogen mixing ratio are determined. The derived value of the molecular hydrogen mixing ratio, $0.89 \pm 0.11$, is consistent with the solar value of 0.86. (auth)

**29189** CYCLIC OCTATOMIC SULFUR: A POSSIBLE INFRARED AND VISIBLE CHROMOPHORE IN THE CLOUDS OF JUPITER. Khare, B. N.; Sagan, C. (Cornell Univ., Ithaca, NY). Science; 189: No. 4204, 722-723(29 Aug 1975).

A brown polymeric material, produced under simulated Jovian conditions, is composed primarily of cyclic octatomic sulfur, although a range of complex organic compounds is also present. The polymeric sulfur, produced from the ultraviolet photolysis of hydrogen sulfide, exhibits its strongest band at 465 reciprocal centimeters, in fair agreement with the frequency of the unidentified Jovian absorber recently announced by Houck et al. Polymeric octatomic sulfur may be an important constituent of the Jovian clouds. (auth)

**29190** OBSERVATION OF A DRIVER GAS-TANGENTIAL DISCONTINUITY. Medrano, R. A. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil); Freeman, J. W. Jr.; Vondrak, R. R.; Hills, H. H. pp 204-218 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A complete analysis of an interplanetary disturbance of Nov. 19, 1970 using the Apollo 12-SIDE (Suprathermal Ion Detector Experiment) is presented. The SIDE detectors were pointing at 26.3 degrees from the normal solar-wind direction during the observations. The data were least-squares fitted (using a parabolic hypersurface approximation) to a convected Maxwell-Boltzmann distribution function. The results of the fit combined with two other experiments showed a drastic change in the wind speed (from a steady 352 km/sec down to 219 km/sec), direction, and temperature. Except for a delta-function increase at the onset, the density remained constant. There was a considerable enhancement in the abundance of He and probably of heavier elements. The interplanetary magnetic field exhibited a jump of 21 gamma with a change in latitude from −56 to −76 degrees in solar ecliptic coordinates. It is concluded that the disturbance was due to the driver gas-tangential discontinuity of a solar flare-induced shock wave. The characteristic of the tangential discontinuity fit well with theoretical prediction. (auth)

**29191** MARINER 10 INTERPLANETARY MAGNETIC FIELD OBSERVATIONS: PRELIMINARY RESULTS. Behannon, K. W.; Lepping, R. P.; Ness, N. F.; Whang, Y. C. (Goddard Space Flight Center, Greenbelt, MD). pp 178-187 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The results being reported consist primarily of distributions of the hourly average field large-scale properties and fluctuation characteristics by solar rotation for the time interval 7 November 1973 to 5 April 1974, as well as the variation of the daily average field as a function of the distance from the sun between 1 and 0.46 AU. The data indicate that the interplanetary magnetic field (IMF) generally increases with decreasing distance from the sun; the field magnitude distribution broadened as Mariner 10 approached Mercury; the positive sector of the IMF tended to rotate progressively toward the theoretical spiral field direction; and magnitude fluctuations increased with increasing distance from the sun, while vector field fluctuations tended to decrease. Data on radial dependence of the IMF were not consistent with theoretical models and did not coincide with extrapolations based on data gathered by Mariner 4 and 5. Comprehensive graphs and charts illustrate all the data obtained by Mariner 10. (IAA)

**29192** ZODIACAL LIGHT ELECTRON MODEL OF INTERPLANETARY SPACE. Salimzibarov, R. B. (Inst. of Cosmophysics Research and Aeronomy, Moscow). pp 154-157 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The physical nature of zodiacal light is examined by evalnating four different models advanced for the phenomenon. Arguments are quoted against the validity of hypotheses that zodiacal light is produced by scattering of solar light on electrons in near-earth space, on dust in near-earth space, and on dust in interplanetary space. The preferred hypothesis is that zodiacal light is caused by scattering of solar light on electrons in interplanetary space, and earlier arguments against this hypothesis are negated by defining conditions under which solar light scattering by interplanetary electrons will match the features of zodiacal light. (IAA)

**29193** INHOMOGENEITY DEGREE OF INTERPLANETARY MAGNETIC FIELD IN 1958-1973. Kuzmin, A. I.; Skripin, G. V.; Flippov, V. A.; Migunov, V. M. (Inst. of Cosmophysics Research and Aeronomy, Moscow). pp 327-334 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Average annual diurnal and semidiurnal variations of muon intensity registered by the lakutsk complex of ground and underground arrays are analyzed. Data of 15 years from 1958 to 1973 are divided into 7 two-year periods for which the amplitudes and phases of the first and the second harmonics of daily variations were calculated. Comparing these data with expected ones the solar wind velocity, inhomogeneity degree of the interplanetary magnetic field and the energy upper boundary of subjected to anisotropy particles are determined. These characteristics vary according to solar activity cycle. (auth)

**29194** HYDROMAGNETIC EMISSION OF THE INTERPLANETARY PLASMA. Gul'elmi, A. V.; Dovbnia, B. V. (Geofizicheskaia Observatoriia, Borok, USSR). pp 232-236 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Observations of geomagnetic pulsations are discussed. The characteristics of these pulsations indicate that they are generated in the interplanetary medium as a result of the cyclotron instability due to the anisotropy of solar wind protons. Pulsations recorded on extremely quiet days within the 0-2 Hz frequency range appeared as dark winding bands, i.e., serpentine emissions. These emissions showed a deep modulation of the carrying frequency. This modulation can be explained by the Doppler-shift and variations in the orientation of the interplanetary magnetic field. (IAA)

**29195** STATISTICAL STUDY OF INTERPLANETARY FLUCTUATIONS. Whang, Y. C. (Catholic Univ. of America, Washington, DC). pp 224-231 of International Symposium on Solar-Terrestrial Physics. Vol. I. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Fluctuations in the interplanetary magnetic field are studied by means of a probability distribution function. The anisotropy of the fluctuation intensities is revealed. A solar wind model is proposed which includes the proton thermal anisotropy and two different temperatures for electrons and protons in the outer region ($r > 0.4$ a.u.). (IAA)

**29196** ASYMMETRIES OF JUPITER'S MAGNETOSPHERE. Komesaroff, M. M. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia); McCulloch, P. M. Mon. Not. R. Astron. Soc.; 172: No. 1, 91-95(Jul 1975).

It is well known that measurements of Jupiter's decimetric radio flux and polarization are incompatible with a centered dipole model of the planetary magnetic field. Here it is shown that departures from a dipolar configuration cannot, by themselves, completely explain the observed variation of polarization position angle with Jovian longitude and that other effects must be invoked, e.g., planetary shadowing or non-rigid rotation of the magnetosphere. Apart from these effects the position angle measurements are consistent with the symmetry of the dual-dipole model of the planetary field, suggested by Smith et al. on the basis of the Pioneer 10 measurements. (auth)

**29197** INTERPRETATION OF SATURN RADIO-RADIATION. Naumov, A. P. Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 17: No. 12, 1755-1764(1974). (In Russian).

The spectra of averaged disc brightness temperature of radiation from Saturn at the wavelength $\lambda \approx 0.8 \div 94$ cm are calculated for some atmosphere models which differ in chemical composition and parameters of the lower cloud layer. It is shown that among the accepted components the quantity of $NH_3$ content has the greatest influence on interpretation of experimental results. A sufficient stability of the quantitative determination of ammonia content over Saturn radiation spectrum for dry and moisture hydrogen and hydrogen-helium atmospheric models is pointed out. (auth)

**29198** THREE-COLOR PHOTOMETRY OF THE TWO GALACTIC STAR CLUSTERS NGC 559 AND NGC 637. Grubissich, C. (Univ., Basel). Astron. Astrophys., Suppl. Ser.; 21: No. 1, 99-107(Jul 1975). (In German).

Three-color photometry of the clusters NGC 559 and NGC 637 in the RGU system has been carried out on plates taken with the Curtis-Schmidt telescope. The first cluster is a heavily reddened old cluster with many late-type giants at a distance of 1.2 kpc or slightly more. The second cluster is a young one at a distance of 2.45 kpc located in the spiral arm +I. The field stars in the area of the two clusters show color magnitude diagrams not very

different from cluster diagrams. They indicate a space distribution in the form of star clouds. The old cluster NGC 559 seems to be embedded in the nearer cloud (1.2 kpc) which consists of young and old stars. (auth)

**29199** STUDIES OF THE LMC STELLAR CONTENT. I. A Catalog of 272 New O–B2 Stars. Brunet, J. P.; Imbert, M.; Martin, N.; Mianes, P.; Prevot, L.; Rebeirot, E.; Rousseau, J. (Observatory, Lyon). Astron. Astrophys., Suppl. Ser.; 21: No. 1, 109-136(Jul 1975). (In French).

From plates obtained with the objective-prism astrograph (dispersion 95 Å $mm^{-1}$) equipped with an intermediate-band interference filter, at La Silla 272 O–B2 stars belonging to the LMC have been detected. Finding charts, 1975 equatorial coordinates, magnitudes and colors in UBV photometry, and spectral classifications for these objects are given. Among them, 105 are classified as O–B0 stars, 135 are classified as B1–2 stars, and for 32 stars, an accurate spectral type could not be assigned. Nevertheless, these stars are confirmed as very hot objects by UBV photometry. Remarks are given concerning positions of stars, spectral types, magnitudes and colors. In the appendix a semi-automatic two-channel photometer used for UBV measurements is described. (auth)

**29200** STUDIES OF GAMMA RADIATION IN THE NEAR EARTH SPACE. Mazets, E. P. pp 198-209 of Problems in Modern Physics. Leningrad; Izdatel'stvo Nauka (1974). (In Russian).

An experimental test of the hypothesis concerning the anti-matter nature of meteors is described. The integrated fluxes of the annihilation radiations which might arise during the entry of antimeteors into the atmosphere were observed. An increase in the intensity of gamma radiation above 0.511 MeV was detected during the peak periods of the Geminids and Ursids meteor showers. (IAA)

**29201** INVESTIGATIONS OF COSMIC DUST. Mazets, E. P. pp 183-197 of Problems in Modern Physics. Leningrad; Izdatel'stvo Nauka (1974). (In Russian).

Critical examination of data from satellite sensors of collisions of meteoric particles has led to the conclusion that the concentration of micrometeors in the earth's vicinity is not significantly greater than the concentration of cosmic dust particles in interplanetary space. (IAA)

**29202** SEARCH FOR EXTINCT $^{146}$Sm. I. The Isotopic Abundance of $^{142}$Nd in the Juvinas Meteorite. Lugmair, G. W.; Scheinin, N. B.; Marti, K. (California Univ., La Jolla, San Diego (USA). Dept. of Chemistry). Earth Planet. Sci. Lett.; 27: No. 1, 79-84(Aug 1975).

The isotopic abundance of Nd in bulk rock samples and in mineral separates of the Juvinas meteorite has been investigated as part of a search for evidence of extinct $^{146}$Sm. The large anomalies in $^{142}$Nd claimed by Notsu et al. (1973) in this meteorite are not confirmed. An upper limit of 2 parts in $10^4$ can be set for this variation in mineral separates of Juvinas, corresponding to an upper limit of $^{146}Sm/^{144}Sm = 0.013$ at the time of solidification of Juvinas, 4.56 AE ago. This result rules against a chronology of $\beta^+$ (p-process) nucleosynthesis which is significantly (more than 10%) spiked near the time of isolation of solar system matter ("last minute" spike). (auth)

**29203** IS JUPITER'S MAGNETOSPHERE LIKE A PULSAR'S OR EARTH'S. Kennel, C. F.; Coroniti, F. V. (California Univ., Los Angeles (USA). Dept. of Physics). Space Sci. Rev.; 17: No. 6, 857-883(Sep 1975).

Two possible models of Jupiter's magnetosphere are compared - a pulsar-like radial outflow model and an earth-like convection model. The kind of super-Alfvenic radial outflow model which the available Pioneer 10 data seem to require is considered, concentrating on estimating the total particle and energy fluxes which must be provided by Jupiter - or its magnetosphere within the Alfven radius - to power the outflow. A convection model is also considered, concentrating upon weakening the objections previously held by theoreticians against a dominant role for convection in Jupiter's magnetosphere. (auth)

**29204** DENOUEMENT OF JOVIAN RADIATION BELT THEORY. Coroniti, F. V. (California Univ., Los Angeles (USA). Dept. of Physics). Space Sci. Rev.; 17: No. 6, 837-856(Sep 1975).

Prior to the Pioneer 10 encounter a concerted theoretical effort was made to construct models of the Jovian Van Allen belt electron fluxes. For the most part, the physics underlying these models is similar to terrestrial radiation belt physics. Thus Jupiter provided an opportunity to test whether the physics of the earth's radiation belts is applicable to other planetary magnetospheres. Even if only partially successful, consideration can be given to exporting this physics to the unseen magnetospheres of planets orbiting other stars. Since several groups worked virtually simultaneously on the theoretical models, it seems appropriate to give a quasi-historical review of the evolution of the basic theoretical ideas. (auth)

# PHYSICS (ATMOSPHERIC)

## Auroral and Ionospheric Phenomena

*Refer also to abstracts 27735, 29001, 29105, 29253, and 29260–29263.*

**29205** (CONF-730750-, pp M1-M27) RADIOWAVE PROPAGATION IN AN INHOMOGENEOUS MAGNETOPLASMA. Walker, A. D. M. (Univ. of Natal, Durban, S. Afr.). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

The theory of radiowave propagation in a plane-stratified magneto-ionic medium such as the ionosphere is reviewed. Such problems are complicated as they involve fourth order equations and non-Herwitian operators. Eigenvalue problems are discussed. Propagation in ducts of ionization and in the earth-ionosphere waveguide is described. (auth)

**29206** RADIATIVE FORCE, ACTING UPON A PARTICLE IN AN ELECTROMAGNETIC FIELD WITH AN ARBITRARY RATIO OF PARTICLE SIZE AND FIELD WAVELENGTH. Kats, A. V. Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 4, 566-576(1975). (In Russian).

The radiative force acting upon a particle in a high frequency electromagnetic field is found. It is expressed in the common case in terms of scattering matrix. The simple formula for the radiative force in the Rayleigh–Gans approximation is obtained. The latter includes extreme cases of large and small particles in comparison to the field wavelength. In a weakly divergent light beam the radiative force is shown to be reduced to the light pressure and the gradient force. The gradient force is found to act upon the particles being optically denser than the medium in the direction of the greater field intensity. The results obtained agree with experimental data. (auth)

**29207** POLARIZATION OF ELECTROMAGNETIC WAVES IN THE IONOSPHERE CONTAINING ANISOTROPIC CONDUCTIVITY. De, S. S.; Biswas, S. (Centre of Advanced Study in Radio Physics and Electronics, Calcutta). Acta Phys. Acad. Sci. Hung.; 38: No. 1, 67-70(1975).

The conductivity tensor for an appropriate ionospheric plasma in presence of an external magnetic field has been evaluated. Longitudinal propagation of electromagnetic waves has been investigated through such a plasma. The various forms of conductivities in the ionosphere have been derived which may be utilised to study their corresponding variations with height as well as with latitude. (auth)

**29208** NEW RESULTS OF INVESTIGATIONS OF NONLINEAR PHENOMENA IN THE IONOSPHERE. Belikovich, V. V.; Benediktov, E. A.; Getmantsev, G. G.; Erukhimov, L. M.; Zuikov, N. A.; Komrakov, G. P.; Korobkov, Yu. S.; Mityakov, N. A.; Rapoport, V. O.; Trakhtengerts, V. Yu.; Frolov, V. L. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 4, 516-526(1975). (In Russian).

The experimental data on the ionospheric plasma disturbance by electromagnetic radiation of the powerful ground-based radio transmitter are presented. The disturbance diagnostics is realized by the vertical sounding method, as well as by the radio astronomical method using the discrete source radio emission. The radio wave attenuation and discrete source intensity scintillations were observed. Possible models which account for experimental data are discussed. (auth)

**29209** POSSIBLE RELATION BETWEEN PERIODIC GLACIATION AND THE FLEXURE OF THE GALAXY. Williams, G. E. Earth Planet. Sci. Lett.; 26: No. 3, 361-369(Jul 1975).

At least five discrete episodes of widespread Earth glaciation or global cooling have occurred since late Precambrian time. A notable feature of such episodes is the ~155-m.y. mean period of their mean ages, key dates being ~770, ~615, ~445, ~295, ~145? and minus ~10? m.y. B. P. Employing the following values for parameters of the Sun's galactic orbit, present circular velocity = 225 ± 25 km $sec^{-1}$, present galactocentric distance = 9.0 ± 0.5 kiloparsec, and eccentricity = 0.1 ± 0.01, it is calculated as a first approximation that the period of the Sun's revolution around the galactic centre is $303^{+\infty}_{-\frac{1}{3}}$ m.y. Assuming that the two galactic regions which appear to be tidally flexed by the Magellanic Clouds are stationary with respect to the galactic center, then the mean period of solar passage between regions of given, diametrically-opposite galactic flexure is $152^{+\infty}_{-\frac{1}{3}}$ m.y. Since the solar system now lies within a little-flexed region of the galactic disc, and the Earth is presently subjected to a climatic regime of high-latitude glaciation, it is suggested that passage through such regions may have resulted in the ~155-m.y. rhythm of Earth glaciation since late Precambrian time. (auth)

**29210** TRAVELLING BIFURCATION OF THE EQUATORIAL $F_2$ LAYER. Chun-ming Huang. (National Taiwan Univ., Taipei). Radio Sci.; 10: No. 5, 507-516(May 1975).

Examination of vertical sounding data shows that a travelling bifurcation occurs mainly near noon in the seasons other than June solstitial months during years of high solar activity. It is found that the formation of bifurcation is principally due to the combined effect of the upward drift, which changes from increasing to decreasing at 1000 LT, and the slow diffusion. The effects of other parameters on the bifurcation and ionospheric characteristics and the cause of the bifurcation which occurs at sunrise are also studied. The continuity equation of electron density is then solved with appropriate values of ionospheric parameters suggested from the above study. The computed $f_0F_2$ at the equator during daytime is a very good reproduction of the observed one, and does not show any bifurcation as usually observed. The causes of agreement or disagreement between the computed and the observed values of critical frequency and height of layer peak are discussed. (auth)

**29211** EFFECTS OF THE AUGUST 1972 MAGNETIC STORMS ON IONOSPHERIC SCINTILLATIONS. Aarons, J. (Air Force Cambridge Research Labs., Bedford, MA); Martin, E. Radio Sci.; 10: No. 5, 547-554(May 1975).

A "worst case" of scintillation activity is presented by the analysis of data of a period of severe magnetic activity, August 3–10, 1972. The effect of the dense ionospheric irregularities produced by these storms on scintillation at high latitudes is viewed as a function of local time and the invariant latitude of the propagation path, as well as magnetic activity. Storm period data taken at high, middle, and equatorial latitudes are analyzed and compared with the seasonal means. In the high-latitude irregularity region, dramatic increases of scintillation index at 254 MHz were noted. Cumulative amplitude probability distribution functions are given for the high-latitude data with the aim of giving to systems designers signal statistical data for "worst case" conditions. Middle-latitude stations show little reaction to the magnetic activity. At equatorial latitudes during July and August, the longitude of the observatory determines the reaction. Accra (Ghana) data show a slight decrease in scintillations during the August storms. At Huancayo (Peru) scintillations increase in the postmidnight period. (auth)

**29212** WORLDWIDE VARIATION IN ATMOSPHERIC NOISE INTENSITIES WITH SUNSPOT NUMBER: AN IN-DEPTH LOOK AT THE 20 TO 24 HOUR SEASONAL TIME BLOCK. Joglekar, P. J. (Vidyalankar Inst., Bombay); Sathiamurthy, T. S. Radio Sci.; 10: No. 6, 601-609(Jun 1975).

Comparisons of the variation of atmospheric radio noise intensities for 20 to 24 hr to sunspot numbers have been completed. Statistical dependence between the noise intensities and sunspot numbers was found for different seasons at a number of frequencies for many locations in the global network of ARN-2 noise recorders. The noise intensities generally tended to decrease with sunspot number in the range from 50 kHz to 5 MHz, which is presumed to be due to increases in residual ionospheric absorption during nighttime. At frequencies greater than 5 MHz, noise intensities increased with sunspot number in many cases, which would be expected from our present knowledge of ionospheric behavior in the HF range. By convention, CCIR treats year-to-year variation in the noise intensities as random and includes them in the prediction uncertainty sigma /sub Fam/ (for which one value is given at a frequency for a seasonal time block for all locations) in system performance evaluation. An error analysis on a global basis shows that a large portion of the year-to-year variability is due to sunspot variation. This suggests the possibility of improved noise estimates. (auth)

**29213** MEASUREMENTS OF ION DRIFT IN THE F-REGION OF THE IONOSPHERE. Williams, P. J. S.; Thomas, D. P. pp 349-355 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29214** F REGION WIND COMPONENTS IN THE MAGNETIC MERIDIAN FROM OGO 4 TROPICAL AIRGLOW OBSERVATIONS. Bittencourt, J. A. (Univ. of Texas, Dallas); Hicks, G. T.; Tinsley, B. A. pp 328-337 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29215** THEORETICAL AND EXPERIMENTAL STUDIES OF THE IONIZATION EXCHANGE BETWEEN THE ATMOSPHERE AND PLASMASPHERE. Cicerone, R. J. (Univ. of Michigan, Ann Arbor). pp 338-347 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29216** EFFECTS OF NEUTRAL WIND VARIATIONS ON THE PLASMA INSTABILITIES IN THE EQUATORIAL ELECTROJET. Reddy, C. A. (Indian Space Research Organization, Trivandrum). pp 391-395; 397 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29217** LOW LATITUDE TRAVELLING IONOSPHERIC DISTURBANCES OBSERVED BY RIOMETER. Abdu, M. A.; Rai, D. B. (Instituto de Pesquisas Espaciais, Sao Jose dos Compos, Brazil). pp 440-451 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29218** ATMOSPHERIC GRAVITY WAVES LAUNCHED BY SUNRISE HEATING AND SUNSET COOLING OF THE ATMOSPHERE. Kaushika, N. D. (Delhi Univ.); Chandra, S. pp 461-469 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29219** ELF AND VLF EMISSIONS AT SUBAURORAL ZONE IN QUIET AND DISTURBANCE PERIODS. Kleimenova, N. G. (Inst. of Physics of the Earth, Moscow); Chukanov, A.; Korotova, G. L.; Smirnova, N. A. pp 267-273 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The emissions observed at two conjugate ground stations situated near the projection of plasmapause are studied. These stations were inside the plasmasphere during quiet magnetic conditions and outside it during disturbance periods. Therefore different emissions at differing frequencies observed corresponded to quiet and disturbed cases. ELF hiss occurrence on quiet days showing a small positive deviation over diurnal variations indicates a compression of the magnetic field near the equatorial plane of the magnetosphere. During moderate activity, some ELF chorus with frequencies from 0.5 to 1.5 kHz was observed; maximum ELF chorus appearance corresponded to low activity (Kp equals 2), while VLF chorus appearance corresponded to disturbed conditions (Kp equals 3-4). It is supposed that the region of ELF chorus generation is very narrow just outside the plasmapause. (IAA)

**29220** ORIGIN AND THE HEIGHT OF THE Sq CURRENT. Volland, H. (Univ., Bonn). pp 385-390 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The solar diurnal tidal wind (1, -1), believed to be the main generator of the geomagnetic Sq current, changes its horizontal configuration between 100 and 200 km altitude. It is shown that this transition does not alter the efficiency of that wind to produce Sq apart from a phase shift of about two hours to later times. The Hall component of the Sq current flows between 100 and 150 km whereas the Pedersen component covers a height range from about 120 km to at least 200 km. This feature of Sq explains the magnitude of the geomagnetic variations observed on the ground, the phase advance by about one hour of the geomagnetic solar flare effect with respect to Sq, and the observed electric polarization field of Sq near 200 km. (auth)

**29221** VHF IONOSPHERIC SCINTILLATIONS AT L = 2.8 AND FORMATION OF SAR ARCS BY MAGNETOSPHERIC HEAT CONDUCTION. Basu, S. (Calcutta Univ.). pp 287-296 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The stormtime 137-MHz scintillation data from ATS-3 following well-defined SSCs of severe and moderately magnetic storms are presented and discussed in terms of their relationship to the Dst main phase of the storm. The total electron content (TEC) measurements made simultaneously from the same station are used to locate the position of the plasmapause. Where available, published observations of SAR arcs are used for comparison with the scintillation data. The SAR arc motion during storms is also utilized to establish whether the observed scintillation is of plasmaspheric (i.e., midlatitude) type or whether it is caused by equatorward motion of the high-latitude irregularity region. These results are then discussed in terms of the magnetospheric heat conduction required for the formation of SAR arcs and the auroral particle precipitation into the ionosphere. (auth)

**29222** CONNECTION OF THE POSITION OF THE POLARWARD BOUNDARY OF THE POLAR CUSP WITH THE INTENSITY OF IPCL. Bol'shakova, O. V. (Geofizicheskaia Observatoriia, Borok, USSR); Troitskaia, V. A.; Hessler, V. P. pp 180-184 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

Some OGO-5 data are presented for the purpose of comparing direct measurements of the shifting of the polar cusp boundaries with corresponding changes in the ipcl amplitudes at high latitudes. It is seen that sharp changes in the polarity of the vertical component (Bz) of the interplanetary magnetic field (IMF) correspond to a shifting of the poleward boundary. When Bz changes its direction from southward to northward, the boundary shifts to the pole. Opposite change of the sign of Bz corresponds to a shifting of the boundary towards the equator. On the average, for eight cases studied, the ipcl amplitude changes approximately 2.8 db for 1 degree of shifting of the poleward boundary of the polar cusp. (IAA)

**29223** LATITUDINAL EFFECTS IN THE EQUATORIAL ZONE MIDDLE IONOSPHERE. Schepkin, L. A.; Goncharov, L. P. pp 235-238 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

In view of previous demonstrations of the presence of the equatorial anomaly effect in the ionosphere at levels of 180 km and higher at low solar activity, latitudinal variation in electron density (N) is investigated. Two causes of the effect are proposed: at heights lower than 200 km, where the influence of plasma transport is small, there is a latitudinal change in electron temperature (Te); at solstice period, a transition occurs from the enhanced atomic oxygen thermospheric composition typical of the winter hemisphere to the enhanced molecular oxygen content prevalent in the summer hemisphere. (IAA)

**29224** LOW LATITUDE F-REGION DURING SUNRISE AND SUNSET PERIODS. Vijayamohan, K.; Jogulu, C. (Andhra Univ., Waltair, India). pp 220-234 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The behavior of ionospheric F-region has been investigated during the sunrise and the sunset periods for quiet and disturbed conditions using ionograms taken at a low latitude station during May, 1968, which is a year of sunspot maximum. Time variations of various parameters during these periods are studied. In most of the cases it is observed that the increase in electron density (N) starts after the ground sunrise and not after the layer sunrise. There is a sharp increase in N immediately after the ground sunrise for about one hour and rate change of N is also maximum during this one hour for the sunrise period. The fall in N during the sunset period occurs even before ground sunset and the fall is very rapid after the ground sunset as indicated by the very high values of rate of change of N. The nature of variation of N(m) is observed to be generally opposite to that of h(m) during the sunrise period. A discussion is made of the results obtained in the light of the earlier work. (auth)

**29225** NIGHTTIME IONIZATION DUE TO INTERPLANETARY NEUTRAL HELIUM. Fahr, H. J.; Blum, P. W. (Univ., Bonn). pp 240-254 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Interstellar neutral helium streams into the heliosphere and is focused strongly by the solar gravitation in the anti-apex direction

of the streaming motion relative to the sun. Due to this effect, relatively high interplanetary helium concentrations of up to 0.5 particles/cu cm are predicted for a distance of about 1 AU from the sun near the ecliptic plane. The earth moves through this helium bulge in winter. The velocity of the helium stream is added to the orbital velocity of the earth. The particle stream is estimated to be above 1 million particles per sq cm per sec during winter and 100,000 during summer. As the helium is neutral, it passes through the magnetosphere undisturbed. The energy of each atom is sufficient to ionize several neutral atoms of the terrestrial atmosphere. This ionization source must be taken into account for the winter ionization balance, especially at night. (auth)

**29226** COMPARISON OF OBSERVATIONS MADE ON THE MESOSPHERE AND LOWER THERMOSPHERE OVER KINGSTON, JAMAICA, USING DIFFERENT TECHNIQUES. Alleyne, H.; Foulkes, P.; Kennliside, W.; Kent, G. S.; MacDougall, J. pp 373-381 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Observations are described that have been made on the atmosphere over Jamaica using laser radar, meteor radar and radio sounding techniques. These permit a study of atmospheric density and wind velocity variations over a height range extending from 70 to 150 km above the earth's surface. A comparison of seasonal averages has been made together with a comparison of individual daily variations for those occasions on which there was simultaneous recording. The atmospheric parameters derived from these measurements show agreement in the regions of overlap and permit a comparison with the predictions of atmospheric tidal theory. The spring equinox is found to be the time of year exhibiting the most regular behavior. There is then present a diurnal oscillation with a vertical wavelength of 15 km accompanied by a semi-diurnal oscillation of much longer wavelength. (auth)

**29227** MEASUREMENTS OF THE OI 5577A INTENSITIES IN THE E AND IN THE F-REGIONS BY MEANS OF INCOHERENT SCATTER AND GROUND AIRGLOW DATA. Sobral, J. H. A. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil). pp 255-271 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29228** IONOSPHERIC HEATING AT ARECIBO: HF ELECTRIC FIELD STRUCTURE AT REFLECTION. Kantor, I. J. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil). Contract F30602-70-C-0187. pp 399-416 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Plasma waves are parametrically excited in the ionosphere by high power radio from an HF transmitter. Observations of these plasma wave enhancements, as the ionospheric maximum plasma frequency is falling through the transmitted frequency, show large periodic variations in the amplitude. These oscillations can be explained in terms of a sweeping of the height of the parametric instability through an Airy type structure of the HF electric field near the reflection height. (auth)

**29229** ATMOSPHERIC WAVE OBSERVATIONS AT ARECIBO. Zamlutti, C. J. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil). pp 417-439 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Multiple pulse incoherent scatter experiments, observing E-region altitudes with height resolution better than 2.4 km, have been carried on at Arecibo from August, 1972 to January, 1973. Neutral temperature, ion-neutral collision frequency and drift velocities were obtained. The results showed an oscillatory behavior of the neutral atmosphere. Evidences of nonlinearities of the atmospheric oscillations are explored. They help to determine the period of the tidal mode consistent with the semi-diurnal tide predicted by the theory. (auth)

**29230** TRAVELLING DISTURBANCES IN THE NIGHT-TIME IONOSPHERE. Jones, T. B. (Leicester Univ., Eng.). pp 452-460 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Traveling ionospheric disturbances (TIDs) were monitored using the high frequency radio Doppler sounding technique. Night-time TID activity, characterized by waves with periods of up to 2 hours, differs radically from daytime TID activity, where 20-min quasi-periods are common. This and other observations show the presence of large-scale disturbances moving with high velocities in a southerly direction in the night-time atmosphere. Their behavior does not conform to classical gravity wave theory. (IAA)

**29231** TRAVELLING PLANETARY SCALE WAVES IN THE IONOSPHERE. Cavalieri, D. J. New York; New York Univ. (1974). 58p. University Microfilms Order No. 75-12,461.

Thesis (Ph. D.).

From an analysis of variations in the received daytime phase of long distance, cesium-controlled VLF data measured over three transmission paths spanning a total of $160^0$ of longitude, travelling planetary scale waves are shown to exist at about 70 km, the daytime VLF reflection height, for the 1970/71 winter. The movement of these waves at 70 km are then compared with the travelling planetary scale waves in the lower stratosphere as detected by the SIRS instrument on Nimbus IV weather satellite during the same period. The VLF phase data are further used to study the major mid-winter warming which occurred during the 1970/71 winter and the results are shown to be consistent with a previous synoptic study of the warming made by Labitzke (1972a). This study demonstrates the usefulness of VLF transmissions for studying major mid-winter circulation changes at ionospheric heights. (Diss. Abstr. Int., B)

**29232** THEORETICAL STUDY OF ELECTRICAL COUPLING BETWEEN THE TROPOSPHERE, IONOSPHERE, AND MAGNETOSPHERE. Dejnakarintra, M. Stanford, CA; Stanford Univ. (1975). 213p. University Microfilms Order No. 75-13,510.

Thesis (Ph. D.).

Electrical coupling between the earth's lower atmosphere and the ionosphere is investigated theoretically as a three-dimensional boundary value problem. Theories are developed for mapping dc and ultra-low-frequency (ULF) electric fields in model atmospheres with conductivities generally increasing with altitude. The effects of the geomagnetic field are taken into account above approximately 70 km altitude. As boundary conditions, a perfectly conducting earth and perfectly conducting geomagnetic field lines above 150 km altitude is assumed. These theories are then applied to two coupling problems: upward mapping of thundercloud electric fields to the ionosphere and the magnetosphere, and downward mapping of ionospheric electric fields to the lower atmosphere. Results indicate that electrical coupling between the lower atmosphere and the ionosphere is much stronger than had previously been believed, and that further inquiries should be made into the relationships between atmospheric electricity and space electricity. (Diss. Abstr. Int., B)

**29233** COSMIC-RAY SPECTRA AND HAGEDORN'S THERMODYNAMIC MODEL. Torsti, J. J. (Turku Univ., Finland). Nuovo Cim., B; 25B: 829-841(11 Feb 1975).

The sea-level muon and proton spectra were computed using Hagedorn's (1965) model for the production of nucleons, pions, and kaons in nucleon-nucleus collisions. The multiplicities and partial inelasticities of these particles were calculated for proton laboratory energy in the range (5-40,000) GeV. The predicted muon and proton spectra show agreement (0-20%) with recent measurements in the range (5-5000) GeV. Thus, Hagedorn's model is very useful in cosmic-ray physics. The results also confirm the absolute primary nucleon spectrum which was built up for this purpose from two recent experimental spectra. (IAA)

**29234** LONGITUDINAL PARTICLE DISTRIBUTION IN THE EXTENSIVE AIR SHOWER DISC. Woidneck, C. P.; Boehm, E. (Kiel Univ.). J. Phys., A (London); 8: No. 6, 997-1004(Jun 1975).

The longitudinal structure of the air shower particles in the shower disc has been investigated using the Kiel air shower array with additional fast-timing equipment. From the time delay measurements the longitudinal density distribution of particles has been derived, which near to the shower core ($r < 10$ m) can be described by $d(t) = 0.39t^{0.9}e^{-0.8t}$. This distribution proves to be similar to the longitudinal dispersion calculated for purely electromagnetic cascades. (auth)

**29235** HEIGHT DEPENDENCE OF THE FREQUENCY OF ELECTRON COLLISIONS WITH MOLECULES IN THE D REGION OF THE IONOSPHERES. Benediktov, E. A.; Grishkevich, L. V.; Ivanov, V. A. Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 17: No. 12, 1891-1893(1974). (In Russian).

The results of the measurement of the frequency of electron collisions at altitudes from 55 to 90 km, obtained by the partial reflection method in the summer of 1970 at Gorki, were reported. The variation of the collision frequency with altitude was shown graphically and compared with results obtained by other inves-

tigators. Possible causes of errors in the measurement and processing of data are discussed. (JSR)

**29236** STRATOSPHERIC ELECTRICITY. Hake, R. D. Jr.; Pierce, E. T. (Stanford Research Inst., Menlo Park, CA). Contract N00014-72-C-0259. pp 47-52 of Second International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere. Boston; American Meteorological Society (1974).

From 2nd international conference on the environmental impact of aerospace operations in the high atmosphere; San Diego, CA (8 Jul 1974).

This paper is concerned with assessing the responsiveness of stratospheric electrification to the aerosol content of the stratosphere. Theory governing the gain or loss of stratospheric ions due to production, recombination, attachment or detachment, and transport is considered. Volcanic influences on stratospheric aerosol content are discussed. The marked fine structure of ion density profiles is shown. It is concluded that the agreement between theoretical predictions and experimentally measured profiles of small ion density is improved if theory incorporates the effects of aerosols. Various other studies in the field are briefly covered. (IAA)

**29237** OPTIMAL SAMPLING OF A STRATOSPHERIC SUDDEN WARMING. Kays, M. D. (Atmospheric Sciences Lab., White Sands Missile Range, NM). pp 112-115 of Second International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere. Boston; American Meteorological Society (1974).

From 2nd international conference on the environmental impact of aerospace operations in the high atmosphere; San Diego, CA (8 Jul 1974).

General characteristics of sudden warming phenomena observed, an optimal data sampling technique, and results of an analysis using the sampling method are presented. The objective analysis agrees quite well with the true signal as the maximum values are at the same position. A Bayesian approach is used to find the optimal sampling strategy. (IAA)

**29238** ANALYSIS OF DATA FROM SPACECRAFT RELATING TO STRATOSPHERIC WARMINGS. Weiss, R.; Anderson, A. D. (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA). pp 116-119 of Second International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere. Boston; American Meteorological Society (1974).

From 2nd international conference on the environmental impact of aerospace operations in the high atmosphere; San Diego, CA (8 Jul 1974).

A detailed study of six different stratospheric warmings is described which establishes that the magnetic indices AE, Ap, and Dst display a marked increase 1 to 3 days before warming phenomena and a marked decrease at 0 and -4 days. The definite correlation of the warming phenomena with the AE index indicates that the auroral electrojet joule heating near 100 km may be the original source of the heating that influences the atmosphere at 50 km and below. Whether this heating is the primary cause or trigger of stratospheric warmings remains to be determined. (IAA)

**29239** EFFECT OF VARIOUS PARAMETERS ON THE DIURNAL VARIATION OF $NO_2$. Beadle, P. C. (British Aircraft Corp., Ltd., Bristol, Eng.). pp 142-146 of Second International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere. Boston; American Meteorological Society (1974).

From 2nd international conference on the environmental impact of aerospace operations in the high atmosphere; San Diego, CA (8 Jul 1974).

An attempt is made to treat the chemistry of the diurnal variation of stratospheric NO2 in isolation from the atmospheric structure and dynamics of the variation. The chemical model employed is thus essentially nonequilibrium. The observed NO concentrations are found to be difficult to explain using currently accepted rate constants; therefore it is concluded that these rate constants are too low, probably by an order of magnitude. The NO2 diurnal variation is similarly difficult to explain, partly since it is dependent on the NO concentration. The most likely sources for NO2 are NO3 and N2O5, the latter being the chief contributor. (IAA)

**29240** STOPPING POWER OF ATMOSPHERIC GASES FOR ELECTRONS. Gupta, P.; Jhanwar, B. L.; Khare, S. P. (Meerut Univ. (India). Dept. of Physics). Physica; 79: No. 3, 311-321 (1975).

The expression proposed by Jhanwar et al. for the energy-loss cross sections and the available excitation cross sections are utilised to calculate the stopping power of He, $N_2$, $O_2$ and atomic oxygen for 30 eV-10 keV electrons. The results for He, $N_2$ and $O_2$ are in satisfactory agreement with other theoretical values while for atomic oxygen the present values are lower than most of the previous results. (auth)

**29241** STUDY OF NEUTRONS AND GAMMA RAYS IN THE ATMOSPHERE. Romanov, A. M.; Miakinin, E. V. pp 210-230 of Problems in Modern Physics. Leningrad; Izdatel'stvo Nauka (1974). (In Russian).

The present work described some investigations concerning the origin of the atmospheric components of cosmic rays and the nature of their solar and geomagnetic modulation. The altitude and energy distribution of slow neutrons were measured by resonance detectors along with the flux of albedo electrons. Measurements were also taken of the flux of superthermal and fast neutrons. Data on altitude and energy distribution of atmospheric gamma rays were obtained by balloon measurements. (IAA)

**29242** HEATING OF THE POLAR IONOSPHERE AND GEOMAGNETIC VARIATIONS. Abramov, L. A.; Alperovich, L. S. pp 290-295 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A number of ionospheric heating mechanisms are discussed. Geomagnetic field effects on convection are usually weak. One of the main energy sources in the polar ionosphere is the precipitation of energetic electrons, which is sharply increased during magnetic storms and substorms. It is concluded that during intensive auroral precipitation the convection can be oscillatory, the layer being heated from above. (IAA)

**29243** OBSERVATIONS OF THE O I 6300 A NIGHTGLOW EMISSION NEAR THE MAGNETIC EQUATOR. Sahai, Y.; Teixeira, N. R.; Sobral, J. H. A. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil). pp 296-309 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Measurements of the O I 6300-A nightglow emission were made with a tilting-filter photometer during January-February, 1973, at Natal near the magnetic dip equator. The nocturnal variations of the emission show a prominent midnight enhancement, and these variations are studied in terms of the F-region electron density and height changes obtained from an ionosonde operating at Natal. These observations are compared with the nocturnal variations of the O I 6300-A emission near 23 S, and a distinct difference is observed. (auth)

**29244** DIFFERENCES BETWEEN OBSERVED AND CALCULATED O I 6300 A AIRGLOW OVER ARECIBO. Sobral, J. H. A. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil). pp 310-327 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Significant differences between calculated and observed 6300 A airglow have been observed at Arecibo, during major ionospheric descents. At times other than during the large ionospheric descents the agreement between the calculated and the observed 6300 A airglow was good. The theoretical calculations of the airglow were based on the Jacchia Model of 1971 and the exospheric temperature was assumed constant during the night. The author suggests an enhancement of the neutral temperature to explain the differences between the theoretical and experimental values during the large ionospheric descents. (auth)

**29245** INFRASONIC WAVES IN THE IONOSPHERE DURING SEVERE THUNDERSTORMS. Rao, G. L. (Univ. of Alabama, Huntsville); Hung, R. J.; Smith, R. E. pp 470-478 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The coupling between the lower and upper atmosphere during severe weather and thunderstorms is investigated from the ionospheric Doppler frequency fluctuations recorded using a three dimensional CW Doppler sounder array. Two events typical of the severe thunderstorms that occurred on May 26, 1973 and March 20, 1974, are chosen for our investigation. The CW Doppler records show a wave-like disturbance with a periodicity of 3 to 5 minutes that persisted for 3 to 4 hours. A possible explanation, based on a theoretical model, is presented. There is good agreement between the experimental observations and the model. (auth)

**29246** VARIATIONS IN THE ELECTRON CONTENT IN THE AUSTRALIAN REGION. Essex, E. A. (La Trobe Univ., Bundoora,

Australia). pp 357-364 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Some comparisons of total electron content measurements of the ionosphere in the Australian region during summer evenings are made. These measurements are in turn compared with some northern hemisphere observations during equinoxes. The difference between the two sets of summer readings is due to a reduction in the neutral winds. In both southern and northern hemispheres, a larger electron content peak is observed in April than in October. This phenomenon could be related to changes in the global atmospheric circulation at the equinoxes. Variation in the O plus - H plus transition level is discussed. (IAA)

**29247** COORDINATED IONOSPHERIC DRIFT MEASUREMENTS. Zherebtsov, G. A.; Kazimirovskii, E. S.; Ferberg, B. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). pp 382-384 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A summary of findings from a study of some peculiarities in polar ionosphere echo fading, based on a previous program of horizontal ionospheric drift measurements by the DI method (use of a spaced receiver with a small base-line), is presented. It was noted that the echo fading had a sharply changing high frequency. An average drift velocity during each observation interval was determined. The high-latitude ionospheric motion peculiarities were revealed by a computation of seasonal distributions of a total velocity vector, the azimuth drift. It is postulated that an independent cell of common circulation exists in high latitudes, especially in the low ionosphere. (IAA)

**29248** STRATOSPHERIC, IONOSPHERIC, AND SOLAR INFLUENCES IN A NEW MAGNETIC INDEX. Brown, G. M. (University Coll. of Wales, Aberystwyth). pp 365-372 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The paper is concerned with the variability in phase of the horizontal magnetic field of earth (H) at a middle latitude station. The number of abnormal quiet days (international quiet days with minimum H occurring in early morning or late afternoon or evening) or AQDs is greater in winter than in summer. This trend is probably linked with the known winter variability in stratospheric circulation. The sunspot cycle is inversely correlated with earth's AQD cycle from 1885 to 1972. This relationship may enable predicting solar activity one-half cycle (5-6 yr) ahead. (IAA)

**29249** OBSERVATIONS AND CALCULATIONS OF ATMOSPHERIC HELIUM 10830 EMISSIONS. Christensen, A. B. (Univ. of Texas, Dallas). pp 279-288 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Observations and computer model calculations of helium excitation and transport were carried out. The following conclusions can be drawn: the dawn helium density in the thermosphere is greater than the dusk helium density by 50 per cent or more, in contrast to the static diffusion models but in agreement with the dynamic models; the computed He 10830 intensities are inconsistent with the observations when use of the new Penning ionization cross section for loss of atomic oxygen is used; conjugate photo-electron precipitation is responsible for excitation of atmospheric helium at middle latitudes, but it is not evident in the observations at the equator or Brazil (L equals 1.1); the computations predict greater conjugate effects than observed, leading to the possibility of strong interhemispheric absorption. (IAA)

**29250** THE AURORA. Hultqvist, B. (Kiruna Geophysical Institute, Kiruna, Sweden). Space Sci. Rev.; 17: No. 6, 787-821(Sep 1975).

The following aspects of the aurora are considered: the distribution of auroral electron and proton precipitation in latitude and local time, the absence of dawn-dusk asymmetry, the polar cusps as sources of auroral particles, the turbulence which scatters auroral particles into the atmosphere, auroral particle pitch angle distributions, interaction of the hot plasma with the ionosphere and the effects of a magnetic field aligned potential difference in auroral arcs. (auth)

## Effects of Nuclear Detonations

**29251** NUCLEAR WEAPONS TESTS AND SHORT-TERM EFFECTS ON ATMOSPHERIC OZONE. Miller, A. J. (National Weather Service, Suitland, MD); Krueger, A. J.; Prabhakara, C.; Hilsenrath, E. pp 81-84 of Second International Conference on the Environmental Impact of Aerospace operations in the High Atmosphere. Boston; American Meteorological Society (1974).

From 2nd international conference on the environmental impact of aerospace operations in the high atmosphere; San Diego, CA (8 Jul 1974).

Observations made when Nimbus 4 passed over a nuclear cloud about three hours after the bomb exploded are presented. Infrared and BUV measurements indicated that the atmospheric ozone level in the area of cloud was significantly less than in areas directly north and south of the cloud. It is noted, however, that it is not possible to state definitively that the ozone depletion was caused by nitrogen oxides released in the nuclear weapons test, and that further observations must be made to clarify the situation. (IAA)

## Magnetospheric Phenomena

*Refer also to abstracts 27755, 29105, 29127, 29183, 29184, 29215, 29219, 29221, 29232, and 29248.*

**29252** (N-75-13707) INTERPLANETARY MEDIUM AND PHYSICS OF THE MAGNETOSPHERE. Skuridin, G. A.; Vanyan, L. L.; Baranov, V. B.; Vaysberg, O. L.; Galperin, Yu. I.; Ershkovich, A. I.; Izakov, M. N. (Eds.). 1972. Translation of Mezhplanetnaya Sreda i Fizika Atmosfery, Nauka Press, Moscow, 1972. (NASA-TT-F-784). 294p. NTIS $8.75.

Various aspects of solar terrestrial physics are considered. Along with articles in which theoretical problems are treated, there are others that describe the results of experiments on spacecraft. (STAR)

**29253** NONSTATIONARY MODEL OF THE DENSITY AND TEMPERATURE DISTRIBUTIONS OF CHARGED PARTICLES ALONG GEOMAGNETIC FIELDS LINES. Polyakov, V. M.; Koen, M. A.; Khazanov, G. V. (Irkutsk State Univ., USSR). Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 4, 511-515(1975). (In Russian).

The numerical solutions of equations of continuity, motion, energy balance for ions $O^+$ and $H^+$ written in the dipole system of coordinates (the geomagnetic latitude $\varphi = 45°$) are given. The conclusion is made about the necessary account for a protonsphere reservoir in the up-to-date ionospheric models. (auth)

**29254** PERIODIC AND NONPERIODIC COMPONENTS IN GEOMAGNETIC SECULAR VARIATION. Yanagihara, K. Mem. Kakioka Magn. Obs.; 15: 87-105(Dec 1973).

Routine observations of the geomagnetic field over the last several decades are examined with the aim of discovering a periodicity on the larger order, as nonperiodicity seems to predominate at small scale. A mathematical analysis of the period is presented, and a direct determination of the periodic and nonperiodic terms is included. The method of least squares is successfully applied to a sum of periodic and nonperiodic terms. The period is about 60 years with an amplitude of 15-16 gamma/yr. (IAA)

**29255** THREE-WAVE INTERACTIONS INVOLVING ONE WHISTLER. Melrose, D. B. (Australian National Univ., Canberra). Aust. J. Phys.; 28: 101-113(1975).

Three-wave interactions in which one of the waves is a whistler and the other two are higher frequency waves are examined. The suggestion by Chiu (1970) and Chin (1972) that radio emission near the fundamental plasma frequency might arise in the solar corona from the coalescence of a whistler wave with a Langmuir wave is shown to be unacceptable because the resonance condition for the three-wave interaction cannot be satisfied. Modifications aimed at overcoming this objection are explored. In particular it is pointed out that a spectrum of Langmuir waves evolves into a spectrum of Z-mode waves because of nonlinear interactions in a magnetoactive plasma, but that the coalescence of a Z-mode wave with a whistler can occur only under implausibly restrictive conditions. Explicit expressions which describe the three-wave interactions are derived, and these are used to treat the scattering of transverse waves (and also of Langmuir waves) by whistlers. It is suggested that such scattering may be important in regions of the solar corona where energetic electrons are trapped. (16 refs) (auth)

**29256** SPILLING OF CHARGED PARTICLES FROM THE RADIATION BELTS AND VARIATIONS IN THE INTENSITY OF THE ELF RADIATION IN THE RECOVERY PHASE OF THE MAGNETIC STORM OF DECEMBER 16–17, 1971. Vakulov, P. V.; Dubinski, Yu.; Zahkarov, A. V.; Kudela, K.; Kuznetsov, S. N.; Kuznetsova, V. A.; Larkina, V. I.; Likhter, Ya. I.; Fisher,

S.; Yuzefovich, I. A. Cosmic Res.; 12: No. 5, 645-652(1974). Translated from Kosm. Issled.; 12: No. 5, 707-715(1974).

Measurements of the fluxes of spilled protons and electrons and the intensities of the elf and vlf radiation during the magnetic storm of 16-17 XII 1971 obtained from the Interkosmos-5 satellite are analyzed. The fluxes of quasitrapped and spilled protons were detected at $L \geq 3.8$; spilled protons were observed outside the plasmasphere. Electron spilling was observed in the early evening hours within the magnetosphere, and it ended at the boundary of the plasmasphere. The electrons were spilled in pulses accompanied by intense pulses of VLF radiation. (auth)

**29257** TERRESTRIAL MAGNETOSPHERE: A HALF-WAVE RECTIFIER OF THE INTERPLANETARY ELECTRIC FIELD. Burton, R. K.; McPherron, R. L.; Russell, C. T. (Univ. of California, Los Angeles). Science; 189: No. 4204, 717-718(29 Aug 1975).

A study of geomagnetic disturbances during 1967 and 1968, for which in situ solar wind observations are available, reveals that the magnetosphere acts as a half-wave rectifier of the interplanetary electric field. The rate of injection of energy into the magnetosphere, as inferred from the strength of the disturbance, is approximately linearly proportional to the component of the electric field from dawn to dusk but is effectively zero if the electric field has a component from dusk to dawn. (auth)

**29258** SOLAR PROTON FLUX STRUCTURES OVER POLAR CAPS AND THEIR SEASONAL VARIATIONS. Gall, R.; Bravo, S. (Universidad Nacional Autonoma de Mexico, Mexico City). pp 108-115 of International Symposium on Solar-Terrestrial Physics. Vol. III. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

**29259** INTENSITY AND ENERGY SPECTRUM OF ELECTRONS ACCELERATED IN THE EARTH'S BOW SHOCK. Anderson, K. A. (California Univ., Berkeley (USA). Dept. of Physics; California Univ., Berkeley (USA). Space Sciences Lab.). J. Geophys.; 40: No. 6, 701-712(Dec 1974).

Shock waves accelerate charged particles in the solar atmosphere, in interplanetary space and around the earth's magnetosphere. Acceleration of both electrons and protons occurs in the earth's bow-shock. The acceleration of protons up to 100 keV appears to be a steady state process and may even occur upstream from the bow shock due to waves generated by reflected solar wind protons. The electrons, on the other hand, are known to be accelerated in or near the shock. The intensity of these electrons ranges from approximately $10^2$ to $2 \times 10^3$ (sr cm$^2$ sec keV)$^{-1}$ at 14 keV. The energy spectrum is not a simple power low and is highly variable. If segments of the spectra are fitted to a power low, slopes ranging from $-2$ to $-4.5$ result over the energy range 0.5 to 100 keV. (auth)

**29260** GEOMAGNETIC IMF EFFECTS AND NEW ELEMENTARY SYSTEMS OF ELECTRIC CURRENTS IN MAGNETOSPHERE AND IONOSPHERE OF THE EARTH. Mishin, V. M.; Aksenova, L. V.; Anistratenko, A. A.; Bazarzhapov, A. D.; Matveev, M. I.; Mishina, N. A.; Nemtsova, E. I.; Saifudinova, T.; Urbanovich, V. D.; Shelomentsev, V. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). pp 59-75 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The present work describes two new current modes whose generation is partly responsible, besides the modulation of known types of magnetospheric currents, for geomagnetic IMF effects. The first type of current is produced through the action of the interplanetary electric field and flows in the magnetopause along the field lines and in the polar ionosphere—these currents are responsible for the high-latitude Svalgaard-Mansurov effect. Their main portion is a polar electrojet near latitude 78 degrees, found both at the day and night sides. The second type of current occurs, presumably, on the magnetopause in the form of diamagnetic currents due to IMF. The IMF y-component produces dawn and dusk current vortices, and the IMF x-component produces a dayside vortex. (IAA)

**29261** COMPARISON OF INTERPLANETARY MAGNETIC FIELD CHANGES AND AURORAL ELECTROJET. Nair, K. N. (Indian Space Research Organization, Trivandrum). pp 213-222 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The effect of the strength, orientation and fluctuations of the interplanetary magnetic field is examined along with the dynamics of the geomagnetic activity in the auroral zone. Compared to other planetary indices, Kp, in spite of many of its disadvantages, is best related, on the average, to electromagnetic conditions of the interplanetary space. Fluctuations of north-south component of the interplanetary magnetic field have considerable influence on the westward auroral electrojet strength. Moreover, westward electrojet is the major contributor to the auroral zone geomagnetic activity. The east-west electric field fluctuations in the magnetosphere promote diffusion and acceleration of changed particles in the magnetosphere. (auth)

**29262** INTERPLANETARY AND AURORAL ELECTRIC FIELDS. Gonzalez, W. D. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos, Brazil); Nakamura, Y.; Mozer, F. S.; Lucht, P. pp 204-212 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

A lag time analysis between the electric field transmitted to the magnetosphere from interplanetary space due to magnetic field reconnection at the magnetopause and the electric field measured with balloons at the auroral zone is presented for magnetically disturbed and not disturbed cases and for more than 300 hours of balloon collected data. For this purpose, a magnetopause reconnection model for an arbitrary direction of the interplanetary magnetic field is used. (auth)

**29263** DIFFERENTIAL ROTATION OF THE MAGNETOSPHERIC PLASMA AS CAUSE OF THE SVALGAARD-MANSUROV EFFECT. Volland, H. (Univ., Bonn). pp 186-203 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

Svalgaard, and independently Mansurov, discovered a correspondence between geomagnetic variations at the geomagnetic poles and the sector polarity of the interplanetary magnetic field (IMF). Heppner noted an asymmetry in the magnetospheric electric convection field observed within the polar caps at ionospheric altitudes which is also related to the sector polarity of the IMF. It is shown that both effects can be consistently explained by differential rotation of the magnetospheric plasma with respect to the earth. If the azimuthal component of the IMF is directed toward dusk, the magnetospheric plasma is slowed down on the northern polar cap and is accelerated on the southern polar cap. If the azimuthal component of the IMF is directed toward dawn, the situation is reversed. It is suggested that this differential rotation is generated by a vertical component of the interplanetary electric field which penetrates into the day side regions of the magnetosphere. (auth)

**29264** PROPAGATION OF ELECTROMAGNETIC ENERGY IN THE MAGNETOSPHERE, MAGNETOTAIL AND SOLAR WIND. Jones, D.; Grard, R. (European Space Research and Technology Center, Noordwijk, Netherlands). pp 226-236 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais(1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The propagation mechanism of electromagnetic energy is investigated in the outer magnetosphere, magnetosheath, and solar wind using a ray-tracing technique. The present study makes use of macroscopic models for the magnetic field topology and electron density distribution. The existence of the bow shock, magnetopause, and plasmapause is taken into account; the distortion of the earth's magnetic field by the solar wind is also included in the models. Results are presented in the form of ray paths. The preliminary results of this study show the possibility for electromagnetic radiation to be trapped between the plasmasphere and the magnetosheath. Focusing and defocusing of the rays is shown to be caused by the concavity of the magnetosphere. The conditions under which electromagnetic waves resulting from type III solar radio bursts have access to the magnetospheric cavity are also considered. (auth)

**29265** PARTICLES AND MAGNETIC FIELD IN THE OUTER GEOMAGNETOSPHERE. Antonova, A. E.; Shabanskii, V. P. (Moscow State Univ.). pp 168-179 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Magnetic field behavior relative to the charge distribution in the outer magnetosphere is considered. The results of Electron-4 and IMP-3 measurements of 200-plus keV electron fluxes are

analyzed. Spatial distribution of such fluxes is shown to agree with the assumption of branching of the longitude drift shell of charged particles. The importance of seasonal and diurnal variations of the geomagnetic dipole axis as well as the inclusion of interplanetary magnetic field in determining magnetospheric shape are discussed. Theoretical distribution of magnetic field is compared to the results of the Mead-Fairfield empirical magnetospheric model derived from satellite data. (IAA)

**29266** INDUCTIVE ELECTRIC FIELDS IN THE MAGNETOSPHERE. Murphy, C. H.; Wang, C. S.; Kim, J. S. (New York State Univ., Albany). pp 146-166 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The generation of inductive electric fields by time-dependent currents in the magnetosphere has been studied. The currents considered include the currents due to the interaction of the earth's magnetic field with the solar wind, neutral sheet current with return currents on the boundary of the tail, and symmetric and asymmetric ring currents. The variations of these currents have been inferred from experimental magnetic field data and the corresponding inductive electric fields are calculated from the time derivative of their magnetic vector potentials. (auth)

**29267** TECHNIQUE FOR EVALUATING MATHEMATICAL MODELS OF THE MAGNETOSPHERE. Smart, D. F.; Shea, M. A. (USAF, Cambridge Research Labs., Bedford, MA). pp 134-143 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

A technique for evaluating mathematical models of the magnetosphere using neutron monitor observations of anisotropic ground-level solar cosmic-ray events is presented. This technique is based upon previously demonstrated success in determining the spectra and spatial anisotropy of the Nov. 18, 1968 cosmic-ray increase. It is assumed that the calculated asymptotic directions for high latitude neutron monitors somewhat differ depending upon the configuration of the magnetospheric model utilized. Sets of asymptotic directions are calculated using different parameters in a mathematical model of the magnetosphere. Using these various sets of asymptotic directions with this technique, the models are evaluated by comparing the calculated increases for the Apr. 29, 1973, ground-level cosmic-ray event. (auth)

**29268** SOLAR WIND ACCESS TO THE PLASMA SHEET ALONG THE FLANKS OF THE MAGNETOTAIL. Bird, M. K. (Univ., Bonn). pp 125-133 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Low-energy particle trajectories in an idealized magnetotail magnetic field are investigated to determine their accessibility to the plasma sheet along the flanks of the tail magnetopause. For certain combinations of particle energy, incident velocity vector, and initial penetration point on the tail magnetopause, the incident particles can become trapped in the plasma sheet, after which their net drift motion then provides a current capable of supporting the entire observed magnetotail field. The results indicate that the bulk of the solar wind plasma just outside the distant tail boundary can be caught up in the tail if the initial penetration point is within about 2 earth radii of the quasi-neutral plane. It is suggested that a large fraction of the magnetotail plasma is composed of former solar wind particles which have penetrated the magnetospheric boundary at the tail flanks. (auth)

**29269** DYNAMICS OF PLASMA SHEET AND DAYSIDE POLAR CUSP ACCORDING TO SOLAR PROTON MEASUREMENTS IN POLAR REGIONS. Ivanova, T. A.; Sosnovets, E. N.; Tverskaia, L. V. pp 116-124 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Displacements of the polar and low-latitude boundaries of auroral regions of 1-MeV solar-proton penetration were studied on the basis of Cosmos-480 data for the flare of Apr. 18, 1972, when a North-South asymmetry of protons in polar caps was observed. The nightside polar boundary of the proton-penetration auroral region during the substorm expansion phase shifts to lower latitudes. The recovery-phase polar boundary shifts polewards. In this case, the width of the proton-penetration region varies from 7 to 14 degrees. Such variations are assumed to relate to variations of the plasma-sheet depth during substorms. The OGO-4 data are used to similarly measure the events of No. 2, 1967. A comparison between the data on solar-proton fluxes beyond the polar penetration boundary at 1000-1500 MLT indicates the possibility of longitude shifts of the cusp toward afternoon hours during magnetic disturbances. (auth)

**29270** DYNAMICS OF THE OUTER RADIATION BELT DURING MAGNETIC STORM OF DECEMBER 17, 1971. Vernov, S. N.; Voroh'ev, V. A.; Zakharov, A. Z.; Kuznetsov, S. N.; Logachev, Yu. I.; Savenko, I. A.; Stolpovskii, V. G. (Moscow State Univ.). pp 1-15 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From International symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The present work analyzes data obtained by the Explorer-45 and Cosmos-426 satellites on the strong magnetic storm of December 17, 1971, and traces on this basis the outer radiation belt dynamics for electrons in five energy levels and in four sectors of local time. The most powerful disturbances were observed during the expansion stage of the storm main phase. Morningside electrons of all energies exhibit the peak intensity. Electron intensities are lower on the day side, even lower on the night side, and minimum on the evening side. The outer radiation belt failed to exhibit the structure characteristic of quiescent periods. The belt boundary for all electrons in all four sectors was until a certain time at an anomalously low L. After this time, the belt boundary shifted to higher L and this process was stopped by the commencement of a new storm. Three magnetic substorms occurred. Apart from the shift to lower L, the belt boundary assumed a quasi-ring nature. (IAA)

**29271** MAGNETOSPHERIC SUBSTORM ASSOCIATED WITH SC. Ondoh, T. (Radio Research Labs., Tokyo). pp 16-21 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The present work describes on the basis of magnetograms at Kiruna and Honolulu and OGO-5 magnetograms a magnetospheric substorm which occurred simultaneously with the sudden commencement of 2345 UT, September 30, 1968. The storm occurred following a gradual development of the plasma sheet thinning under a continuation of the southward interplanetary Bz field. Gradual increases of B and Bx fields and gradual decrease of the Bz field were observed at the OGO-5 during plasma sheet thinning. A large increase of the By field began simultaneously with a southward turning of the northward Bz field at the OGO-5 during sudden commencement rise time. This increase, which amounted to 30 gammas, may be explained by the field-aligned current of 0.024 A/m flowing into the dawn-side auroral zone. (IAA)

**29272** DISCRETE ACTIVIZATIONS OF MAGNETOSPHERE DURING SUBSTORMS. I. Microsubstorm. II. The Longitudinal Localization of Active Region. Sergeev, V. A. (Leningrad State Univ.). pp 22-58 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Some typical satellite and ground data on magnetosphere substorms are used to show that the explosive phase of some typical substorms consists of several microsubstorms. The signs for each microsubstorm are intensification and poleward displacement of auroral bulge and the westward electrojet, longitudinal expansion of the active region, intensification of partial DR current, disruption of neutral sheet currents in the magnetotail region which is restricted along both Xsm and Ysm, and plasma sheet thinning tailward of the current disruption region and by plasma sheet recovery inside of this region. Multistage development of magnetospheric substorms seems to be inherent to the magnetotail plasma-magnetic field system, but it is not caused by abrupt changes in the surrounding solar wind. If reconnection in the magnetotail is the cause of magnetospheric substorms, then microsubstorm phenomena correspond to a short-lived intensification of reconnection in the different parts of the magnetosphere. (IAA)

**29273** DEVELOPMENT OF THE SUBSTORM IN AURORAL RADIO ABSORPTION. Hargreaves, J. K. (Lancaster Univ., Eng.); Chivers, H. J. A.; Axford, W. I. pp 79-88 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The present work examines some aspects of the behavior of auroral radio absorption at and before absorption onsets. Data

from a meridional chain of riometers operated in Alaska show that nearly all onsets are immediately preceded by some form of absorption activity at a higher or lower latitude. Of the various forms of pre-onset absorption that can occur, one of the most significant is that where sudden onset is preceded by a weak absorption bay that invariably moves slowly towards the equator. Calculations of the velocity of the bays, assuming that bay motion is an EXB drift, suggest that the equatorward drift of the bay reflects the inward convection through the magnetosphere of an active region which is a source of auroral precipitation at relatively low intensity. (IAA)

**29274** RELATIONSHIP BETWEEN GEOMAGNETIC Pc3 PULSATION AMPLITUDE AND THE INTERPLANETARY MEDIUM PARAMETERS. Kuklin, V.; Parkhomov, V. A.; Vinogradov, P. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). pp 345-350 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The dependence of the Pc3 pulsation amplitude (T equals 10 to 45 sec) on the solar-wind velocity and concentration, interplanetary-magnetic-field components, and Mach-Alfven number are considered. By means of a statistical multivariate analysis of experimental data it has been shown that the pulsation amplitude is most closely connected with the solar-wind velocity. A clear relationship, but with a smaller correlation coefficient, is found between the Pc3 pulsation amplitude and the radial and tangential projections of the interplanetary-magnetic-field vector on the ecliptic surface. The nature of the relationship of the Pc3 pulsation properties to the solar wind and the parameters of the interplanetary magnetic field is discussed. (auth)

**29275** DYNAMICS OF THE PLASMAPAUSE AND GEOMAGNETIC PULSATIONS. Vorotnitskaia, N. M. (Leningrad State Univ.); Dmitrieva, L. A.; Raspopov, O. M.; Kopytenko, Yu. A.; Loginov, G. A. pp 325-335 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

The present work makes a comparison between the characteristics of Pc3 pulsations of 10-300-sec period recorded simultaneously along a meridional profile and the statistical plasmapause position under conditions of strong and varying magnetic activity. Two regions of full horizontal vector amplitude maxima are shown to exist, one in the mid latitudes inside the plasmasphere, the other in the high latitudes in the region of the outer radiation belt. The subauroral minimum of pulsation amplitude is located between the two maxima. The position of the statistical plasmapause projected onto the earth's surface is located between the subauroral minimum and the high-latitude pulsation amplitude maximum. Shifting of subauroral pulsation amplitude minimum is always accompanied by shifting of the plasmapause. (IAA)

**29276** INFLUENCE OF THE THERMAL CONDUCTIVITY ANISOTROPY IN THE RAYLEIGH PROBLEM FOR THE PLASMA SHEET. Abramov, L. A.; Alperevich, L. S. pp 317-320 of International Symposium on Solar-Terrestrial Physics. Vol. II Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

Conditions sufficient to create an oscillatory convective instability in a horizontal layer of an anisotropic plasma are considered. The problem is relevant to the known phenomenon that a layer of electrically conducting fluid heated from below and magnetized with a strong field can become "overstable." This phenomenon is important in astrophysical problems (e.g., the generation of magnetohydrodynamic waves in sunspots) and in the physics of the upper ionosphere. (IAA)

**29277** MODULATION OF vlf EMISSION BY IRREGULAR Pi2 PULSATIONS. Korotova, G. I. (Leningrad State Univ.); Raspopov, O. M.; Kleimenova, N. G. pp 321-324 of International Symposium on Solar-Terrestrial Physics. Vol. II Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

Modulation of the intensity of VLF emissions that was observed at ground stations is typical of Pi2 pulsations, which were observed in the night sector of the magnetosphere. These pulsations correspond to compressional waves in the magnetosphere, which can strongly influence the VLF source. Comparison of the Pi2 pulsations and VLF envelope spectra helped localize the source of the modulation. During the second of the two Pi2 bursts observed, the local precipitation of energetic particles was observed in the vicinity of the plasmapause. (IAA)

**29278** FULL WAVE VLF MODES IN A CYLINDRICALLY SYMMETRIC ENHANCEMENT OF PLASMA DENSITY. Nunn, D.; Laird, M. J. (King's College, London). pp 307-311; 313-316 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The present report is concerned with the degree of attenuation of propagating modes in ducts consisting of field aligned enhancements of plasma density which channel VLF waves in the magnetosphere. A mathematical development of the problem demonstrates that these enhancements can convey VLF wave energy almost without loss. This result accords with the observed behavior of VLF waves. (IAA)

**29279** DEFINITION OF EFFECTIVE COLLISION FREQUENCY FOR THE TURBULENT MAGNETOSPHERIC PLASMA. Barsukov, V. M.; Pudovkin, M. I. (Leningrad State Univ.). pp 297-304 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The experimental data on statistical characteristics of hydromagnetic fluctuations from ATS-I satellite were used for estimation of the effective collision frequency. This effective frequency was found to be 10,000,000 per sec, which is approximately 10 to the 10th power times as high as the frequency of Coulomb pair collisions. The opportunity to use the satellite magnetometer data for the definition of the effective parameters of turbulent magnetospheric plasma is briefly discussed. (auth)

**29280** CHARGED PARTICLE PRECIPITATION AND LOW-FREQUENCY RADIATION CHARACTERISTICS DURING MAGNETIC STORMS ACCORDING TO THE INTERCOSMOS-5 DATA. Vakulov, P. V.; Gombosi, T.; Dobrovolska, B.; Dubinskii, Yu.; Zakharov, A. V.; Kudela, K.; Kuznetsov, S. N.; Kuznetsova, V. A.; Larkina, V. I.; Likhter, Ya. I. (Moscow State Univ.). pp 274-286 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose Dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

Measurements of electron and proton fluxes and very low frequency (VLF) radiation intensities obtained during the magnetic storms of Dec. 17, 1971, and Mar. 7, 1972, are presented. It was noted that the intense 0.5-11 MeV proton precipitations at storm time were observed on the earth's evening side beyond the plasmapause, intense fluxes precipitating along the magnetic force line indicate that the pitch-angles should vary considerably within a period less than the half-time of proton motion from one hemisphere to another, i.e., within a second or fractions of a second, and intense electron precipitations were observed on the morning side beyond the plasmasphere and on the early evening side within the plasmasphere; the precipitations fluctuated strongly and correlated with VLF radiation. (IAA)

**29281** MEDIUM LATITUDE ELF AND VLF EMISSIONS AND THE MID-LATITUDE TROUGH IN ELECTRON DENSITY. Hughes, A. R. W. (Sheffield Univ., Eng.); Gibbons, W.; Tulnay, Y. K. pp 257-263 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The extent to which the observations of ELF and VLF waves by Ariel 4 are consistent with generation by the cyclotron resonance instability is examined. In this context the plasmapause is an important boundary; probe measurements of electron density were used in the study to indicate the position of the plasmapause. It is found that the intensity of emission at higher frequencies increases relative to the lower frequencies with increasing latitude. This finding agrees with previous spectra obtained from the cyclotron resonance instability mechanism. (IAA)

**29282** SYNTHETIC THEORY OF PROPAGATION PHENOMENA IN THE MAGNETOSPHERE. Selzer, E. (Univ., Paris). pp 249-256 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil: Instituto de Pesquisas Espaciais (1974). (In French)

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

A synoptic explanation is offered of some previous experimental results, which point to a "quasi-synchronism" in the manifestation

at the ground of several events occurring in interplanetary space and in the magnetosphere. A brief review of the results, which did not conform to any formal propagation laws, is given. An analogy is made between the propagation of a wave of magnetic energy in the magnetosphere and the propagation of a diffusion or thermal wave. An infinitely small fraction of the energy could propagate itself instantaneously. There would be no definite propagation speed, and the durations of travel of the waves would depend entirely on the sensitivity of the receiving stations at the ground. Further refinement of time readout techniques for the arrival of the wave at the ground will yield better experimental results. (IAA)

**29283** WAVEGUIDE IN THE MAGNETOSPHERE NEUTRAL SHEET. Raspopov, O. M. (Leningrad State Univ.). pp 237-247 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 June 1974).

The distribution of Alfven velocities (Va) in the neutral and plasma sheets of the magnetosphere is evaluated. This information aids in understanding the generation and propagation of magneto-hydrodynamic waves in the magnetosphere. Three regions with differing Va values can be observed in the magnetosphere tail: the neutral sheet with Va equal to 100km/sec, the plasma sheet with Va equal to 500 km/sec, and the region beyond the plasma sheet with Va equal to 1000-1500 km/sec. The sharp Va gradient at the neutral sheet boundary and the rapid change in geomagnetic field direction lead to waveguide channel formation. The formation of the wave packets responsible for the generation of Pc2 pulsations 8-12 seconds long in the polar cap is probably connected with the existence of this waveguide channel. (IAA)

**29284** DIGITAL SPECTRA OF ARTIFICIALLY STIMULATED VLF EMISSIONS. Stiles, G. S. Stanford, CA; Stanford Univ. (1975). 230p. University Microfilms Order No. 75-13,605.

Thesis (Ph. D.).

New features of artificially stimulated VLF emissions from the magnetosphere have been discovered by using high resolution digital spectra analysis techniques. Several hundred emissions triggered by three VLF transmitters have been examined. The stimulated emissions initially grow at the frequency of the triggering signal. The NAA-triggered emissions remain at the triggering frequency until the transmitted pulse terminates; Siple and Omega emissions may show the same behavior or may break away prior to termination. The emissions always initially rise above the frequency of the triggering signal; this rise is independent of the final slope of the emissions. Where the rise occurs at the termination of the triggering signal it is usually very repeatable from event to event. Following the initial rise the frequency may often level off several hundred Hz above the triggering signal, forming a short (40-100 ms) plateau that precedes the final rising or falling phase. The bandwidth of the emission, prior to where it breaks away from the triggering signal, may be the minimum measurable (approximately 27 Hz) with the given time resolution (approximately 30 ms), indicating that the emission is practically monochromatic. The emissions characteristically show exponential growth in time with rates that vary from 25 to 250 dB/s. These observations are in good agreement with a theory that attributes the emissions to an interaction between the triggering signal and counter-streaming gyro-resonant electrons. The analysis method employed in these studies is based upon the fast Fourier transform and economically produces detailed spectra with resolutions in time and frequency of approximately 30 ms and 50 Hz, respectively. (Diss. Abstr. Int., B)

**29285** SOLAR PARTICLE PENETRATION THROUGH THE MAGNETOSHEATH. Domingo, V.; Page, D. E.; Wenzel, K. P. (European Space Science Dept., Noordwijk, Netherlands). pp 96-107 of International Symposium on Solar-Terrestrial Physics. Vol. II. Sao Jose dos Campos, Brazil; Instituto de Pesquisas Espaciais (1974).

From international symposium on solar-terrestrial physics; Sao Paulo, Brazil (17 Jun 1974).

Data from HEOS-2 and from the NOAA experiment on Explorer 41 are presented which demonstrate that often the bow shock and magnetosheath seriously distort the flux of 1-MeV solar particles, so that it is no longer valid to assume that the magnetopause is the boundary between the interplanetary medium and the magnetotail. The change in absolute value and direction of the flux of particles that might be expected to occur at the magnetopause is not always seen exactly at that point. Rather, this change occurs sometimes further away in the magnetosheath, and sometimes the magnetopause looks completely transparent to arriving energetic particles as if the magnetotail were a continuation of the magnetosheath. (IAA)

**29286** MAGNETOSPHERES OF EARTH AND JUPITER AFTER PIONEER 10. Prakash, A.; Brice, N. (Cornell Univ., Ithaca, N. Y. (USA). Center for Radiophysics and Space Research). Space Sci. Rev.; 17: No. 6, 823-835(Sep 1975).

Possible reasons are pointed out for the remarkable differences observed between the magnetospheres of earth and Jupiter and a model of Jupiter's magnetosphere is given which sheds light on the observations of Pioneer 10 mission and gives some idea of the interesting features one should look for during the forthcoming Pioneer 11 flyby of Jupiter. But a crucial test of the model requires a flyby in which plasma detectors look out towards the planet to detect magnetospheric plasma predicted to be flowing out (at Alfvén speed) from a region surrounding the planet, a possibility for the Mariner Jupiter (MJS) mission planners to consider. (auth)

**29287** GEOMAGNETIC DISTURBANCES AND COMPLEX SUNSPOTS. Horng, J. T. (Radio Physics Group, Telecommunication Laboratories, Chung-Li, Taiwan, China). Astrophys. Space Sci.; 35: No. 2, L33-L34(Jul 1975).

Statistical results show that a large geomagnetic disturbance is most likely to occur at the time when a complex sunspot is in 6.7°E-19.9°E from the central meridian of the solar disk during the period 1968-1972. (auth)

**29288** ON THE EARTH'S BOW SHOCK MOTION AND SPEED. Formisano, V.; Mastrantonio, G. (Laboratorio, Plasma Spazio, C. N. R. Frascati, Italy). Space Sci. Rev.; 17: No. 6, 781-786 (Sep 1975).

Völk and Auer (1973) have recently considered the interaction of tangential discontinuities (TD) and Alfvén waves with the bow shock in order to explain the shock motion and speed. The conclusion was that Alfven waves can cause very slow shock motions (up to 10 km $s^{-1}$) while a TD hitting the bow shock can generate much higher speeds if the density ratio across the TD is high enough. Völk and Auer (1973) however believed that large density ratios across TD were rarely observed, therefore found it difficult to explain the average value (75 to 85 km $s^{-1}$) found by Formisano et al. (1973). It is the intention to verify experimentally with the HEOS-1 plasma data the importance of TD for the bow shock motion and speed. (auth)

**29289** HIGH FLUENCES OF LOW ENERGY (10-25 MeV/amu) C, N, O AND HEAVIER IONS AT 450 km ALTITUDE; RESULTS FROM THE SKYLAB EXPERIMENT. Biswas, S.; Durgaprasad, N.; Nevatia, J.; Venkatavaradan, V. S. (Tata Inst. of Fundamental Research, Bombay (India)); Goswami, J. N.; Jayanthi, U. B.; Lal, D.; Mattoo, S. K. (Physical Research Lab., Ahmedabad (India)). Astrophys. Space Sci.; 35: No. 2, 337-347(Jul 1975).

High fluences (i.e. the integrated fluxes) of C, N, O group of nuclei and some of the heavier ones, in the energy interval 10-25 MeV/amu, have been identified in a Lexan polycarbonate detector assembly exposed on the exterior of the Skylab for 73 days. The existence of large flux of low energy nuclei in the Skylab orbit is surprising since the minimum geomagnetic cut-off energy for fully stripped nuclei (A/Z = 2) is ≃ 50 MeV/amu at the orbit of the satellite, and the period of exposure was a "quiet" one, free from significant solar particle events. Two sources have been considered for these particles: partly ionized interplanetary ions accelerated within the magnetosphere and heavy nuclei trapped in the Earth's radiation belt. The flux and composition of the nuclei observed seem to be significantly different from those in the trapped radiation as known at present; hence it seems likely that the major part of the observed flux may be interpreted in terms of partly ionized interplanetary ions that are further accelerated in the magnetosphere. (auth)

**29290** OPEN AND CLOSED MAGNETOSPHERIC TAIL CONFIGURATIONS AND THEIR STABILITY. Birn, J.; Sommer, R.; Schindler, K. (Bochum Univ. (F. R. Germany)). Astrophys. Space Sci.; 35: No. 2, 389-402(Jul 1975).

The asymptotic theory valid for magnetospheric tail configurations that vary only weakly in the antisolar direction is used to derive a number of explicit properties. The conditions under which the magnetopause converges to form a closed magnetosphere or diverges (open magnetosphere) are identified and discussed. It is shown that the presence of the high latitude low pressure tail lobes guarantees the open solution. The large value of the Mach-number of the unperturbed solar wind is the reason for the slow variation of the plasma and field quantities along the tail. Criteria for (two dimensional) stability are discussed and it is shown that they can be expressed in terms of simple topological properties of the equilibria. Closed magnetospheres turn out to be stable, open magnetospheres with sufficiently stretched field lines are subject to an instability which - as shown earlier - may be the cause of magnetospheric substorms. (auth)

**29291** WAVE-PARTICLE INTERACTIONS IN THE OUTER MAGNETOSPHERE: A REVIEW. Fredricks, R. W. (TRW Systems Group, Redondo Beach, Calif. (USA)). Space Sci. Rev.; 17: No. 6, 741-780(Sep 1975). 123 refs.

Wave-particle interactions are important to the detailed understanding of many geophysical phenomena. Their role as currently understood in the Earth's bow shock is discussed, with the conclusion that their role in proton thermalization remains a mystery. The magnetopause region is considered and it is pointed out that practically nothing is understood there on sound theoretical grounds. The role of wave-particle interactions due to VLF and ELF electromagnetic waves and electrostatic waves present in the plasmaspheric and exo-plasmaspheric regions of the outer magnetosphere is reviewed. Here, one sees a relative triumph of intellectual understanding of many observed properties of the inner trapped electron belt based on careful application of wave-particle interactions to pitch-angle diffusion theory. One also sees a glimmering of incipient understanding of the ring current morphology, again utilizing concepts involving wave-particle interactions. The state of knowledge of current-driven turbulence, and anomalous resistivity produced by it (a wave-particle interaction) in the outer magnetosphere is also considered. Here, high-altitude field-aligned currents appear to produce local anomalous resistivity and extrapolations of isolated spacecraft measurements indicate that this resistivity may support electric potential drops along auroral zone L-shells. (auth)

# PHYSICS (ATOMIC AND MOLECULAR)

**29292** REGGEON RESCATTERING IN PHI$^4$-THEORY. Gershkevich, M. V.; Efremov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 24: No. 1, 17-23(Jul 1975). (In Russian).

In the $\alpha$-representation all logarithms of the Mandelstam diagram in the $\varphi^4$-theory are summed up. It is shown that in spite of the absence of rapid decreasing of the off-shell scattering amplitude, the rescatterings of the Regge poles as well as the fixed square-root branching points, which are present in the $\varphi^4$-theory together with the Regge poles, are correctly described by the usual formula. (auth)

**29293** DETERMINATION OF THE K-SHELL FLUORESCENCE YIELD OF ANTIMONY USING THE PROPORTIONAL COUNTER TECHNIQUES. Hribar, M.; Kodre, A.; Pahor, J. (Ljubljana Univ. (Yugoslavia). Dept. of Physics; Institut Jozef Stefan, Ljubljana (Yugoslavia)). Z. Phys., A; 272: No. 4, 413-415(1975).

From the spectra of electrons emitted in photoelectric absorption of europium K$\alpha$ radiation in antimony, the K-shell fluorescence was determined as $\omega(K) = 0.873 \pm 0.010$. A multiwire proportional counter filled with methane and a small admixture of stibine, $SbH_3$, was employed as a spectrometer. (GE)

## Beams and Their Reactions

**29294** (JINR-9-8120) CHARGED PARTICLE BEAM FOCUSING BY MEANS OF A NONMODERATED E-WAVE. (Joint Inst. for Nuclear Research, Dubna (USSR). Dept. of New Acceleration Methods). 1974. 17p. (In Russian). INIS.

4 refs.; 3 figs.

A variant of alternating focusing—unmoderated E wave and constant magnetic field—is considered. It is shown that with a definite ratio between the cyclotron frequency and the frequency of a high frequency field a beam emittance may be decreased. (tr-auth)

**29295** HIGH-CURRENT ELECTRON BEAMS. Fleischmann, H. H. (Cornell Univ., Ithaca, NY). Phys. Today; 28: No. 5, 35-43(May 1975).

The treatment of high current electron beams covers the technology of beam generation, beam propagation, the beam–pellet approach to fusion, field-reversing electron rings, plasma heating, high power lasers, high power microwaves, ion acceleration, and the development of further applications. (JFP)

**29296** EQUILIBRIUM STRUCTURE OF RELATIVISTIC BEAMS. Meierovich, B. E.; Sukhorukov, S. T. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1783-1796(May 1975). (In Russian).

The structure of a stationary, equilibrium, cylindrically symmetric relativistic beam is investigated. Conditions are found for which collective interaction between the electrons and ions ensures self-containment of the beam. It is demonstrated that within the framework of the Maxwell equations and kinetic equations for classical ideal electron and ion gases, a stationary equilibrium state of beams with a finite particle density is possible only in the particular case of a definite relation between the temperatures and particle concentrations. On the other hand in the general case only solutions with singularities at the origin may exist. In this case a significant part of the total number of particles may be condensed near the beam axis. The infinite particle density at the origin indicates that the approximation of a classical ideal gas cannot be applied for determining the beam structure. If the electron temperature is not small the structure of a compressed relativistic beam will be determined by the quantum properties of the electrons. Within the framework of quantum statistics stationary quilibrium beams can be realized without any relation between the parameters, and their region of existence increases with the degree of electron degeneracy (with the increase of number of electrons). The beam structure is analyzed analytically for the extreme case of strongly degenerate electrons. (auth)

**29297** SMALL-ANGLE MULTIPLE SCATTERING OF IONS IN THE SCREENED COULOMB REGION. II. Lateral Spread. Marwick, A. D. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment); Sigmund, P. (Copenhagen Univ. (Denmark). H. C. Oersted Inst.). Nucl Instrum. Methods; 126: No. 3, 317-323(15 Jun 1975).

The lateral spreading of an initially narrow well-collimated ion beam by multiple scattering in a random medium is evaluated in the small-angle approximation. For scattering cross sections of the power form, lateral distributions are shown to be identical with rescaled angular distributions, calculated within the same scheme as in paper I of this series. For Thomas-Fermi scattering angular distributions can be scaled into approximate lateral distributions by means of the relation $\rho = \alpha\chi/\Gamma$, where $\rho$ is the lateral displacement, $\alpha$ the angular deflection, $\chi$ the thickness, and $\Gamma$ a function of the reduced thickness parameter $\tau$. The quantitative estimate of $\Gamma$ is based upon an equivalent power cross section that depends monotonically on $\tau$. The accuracy of the scaling is shown to be excellent. (auth)

**29298** EFFECT ON THE QUALITY OF HIGH-ENERGY BEAMS OF NONLINEARITIES IN THE FIELD OF MAGNETIC QUADRUPOLES. Carey, D. C. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Nucl. Instrum. Methods; 126: No. 3, 325-339(15 Jun 1975).

Nonlinearities in the field of magnetic quadrupoles will affect the quality of any beam in which they are used. Good field-regions or image-quality determinations can be made by exploring the phase space transmitted by the beam line. The error field of each quadrupole disturbs the trajectory of any particle passing through it. An efficient method is presented for approximating the effect of this disturbance. The integral equation of motion is solved approximately by a single Green's function iteration, giving an expression linear in the non-quadrupole terms in the magnetic field. This expression can then be evaluated by a linear approximation to the particle orbits in the quadrupole. The field is decomposed into multipoles, the effects of different orders are generated recursively, and the results are summed to obtain the net disturbance. (auth)

**29299** CHARGE EQUILIBRIUM FRACTIONS OF $^{11}B$, IN $N_2$, $O_2$, $D_2$, AND He. Arevalo, H. M.; Baragiola, R. A.; Salvatelli, E. R. (Comision Nacional de Energia Atomica, San Carlos de Bariloche (Argentina). Centro Atomico Bariloche). Nucl. Instrum. Methods; 126: No. 3, 469-471(15 Jun 1975).

In order to obtain information for the use of neutral-beam implantation for control of characteristics of semiconductor devices, charge equilibrium fractions of $^{11}B$ in $N_2$, $O_2$, $D_2$, and He were measured in the energy range 25-65 keV. The highest values found for the neutral fractions are of the order of 50%. (auth)

**29300** RECENT ATOMIC AND MOLECULAR BEAM RESEARCH. Sanders, P. G. H. (Oxford Univ. (UK). Clarendon Lab.). pp 59-62 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The great days of beam resonance research when many universities and government laboratories had groups measuring nuclear spins, atomic hyperfine structures, molecular constants, etc. are clearly over. But the subject is far from dead. The important qualities of sensitivity, precision and freedom from perturbing effects which originally led to the development of the method are still extremely valuable. The emphasis now is on fundamental work which cannot be done in any other way. The current situation is examined here by looking at a number of examples. No attempt at completeness is made; the choice of topics reflects the author's interests and much important work has necessarily been omitted. Excellent reviews in the area have been given recently by Childs (1973) and English and Zorn (1972). (auth)

**29301** DIAGNOSTICS OF AN r. f. SPUTTERING GLOW DISCHARGE—CORRELATION BETWEEN ATOMIC ABSORPTION AND MASS SPECTRSCOPY. Eckstein, E. W.; Coburn, J. W.; Kay, E. (IBM Research Laboratory, San Jose, California, USA). Inst. J. Mass Spectrom. Ion Phys.; 17: No. 2, 129-138(Jun 1975).

In a neon r. f. sputtering glow discharge with a copper target, the $Cu^+$ ion current, measured by glow discharge mass spectrometry, is shown to be proportional to the product of the densities of the neutral Cu atoms and the neon metastable atoms, both determined by atomic absorption spectroscopy. This result supports the premise that Penning ionization is the dominant process for the ionization of trace species in this type of glow discharge and also provides confidence in the reliability of mass spectrometric diagnostics of a glow discharge. A discussion is presented of the relationship between the sputtering rate of the copper target and the neutral Cu atom density in the discharge as the discharge pressure is varied. (auth)

**29302** INTERACTION AND REACTION OF DYNAMICAL $O_2$-MOLECULAR BEAMS WITH Ge, Si, AND GRAPHITE SURFACES. Schuetze, C.; Schuegerl, K. (Technische Univ. Hannover (F. R. Germany). Inst. fuer Technische Chemie). Z. Phys. Chem.

(Frankfurt); 95: No. 1-3, 107-118(1975). (In German).

Dynamical $O_2$-molecular beams were directed to the surfaces of single crystals of germanium and silicon with the orientation (111) and to graphite targets. The momentum due to the beam molecules, the accommodation coefficients of normal momentum and the reaction probabilities were evaluated as a function of the target temperature. The results are discussed. (auth)

**29303** SPATIAL REDISTRIBUTION OF A CHARGED PARTICLE FLUX IN A CRYSTAL LATTICE. Kumakhov, M. A. (Moscow State Univ.). Usp. Fiz. Nauk; 115: No. 3, 427-464(Mar 1975). (In Russian).

This review deals with the problem of the passage of charged particles through a crystal lattice and the determination of the position of an impurity atom within the lattice cell. Section 1 is introductory in character. Section 2 considers the effect of the spatial redistribution of a charged particle flux during axial channelization. Consideration is given to the effect of multiple scattering on the magnitude of the flux both at large and also at small depths. A connection is shown between the position of an impurity atom and the position of peaks in the angular distribution. Section 3 considers the flux redistribution and multiple scattering during channelization along a plane. Section 4 deals with the channelization of heavy ions. A technique is presented of calculating the spatial distribution of incorporated ions while taking into account the effect of channelization. Section 5 presents a review of experiments on determining the position of an impurity atom within the lattice cell. 135 refs. (SJR)

**29304** ANGULAR DISTRIBUTION OF ELECTRONS BEHIND BARRIERS COMPARED WITH THE EXTRAPOLATED MEAN FREE PATH. Boiko, V. I.; Evstigneev, V. V. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 35-38(1975). (In Russian).

The angular distribution of monoenergetic betatron electrons, passing through barriers of Al, Cu, and Pb, whose thickness satisfies the extrapolated mean free path, was studied. The original energy range was 3 to 8 MeV. The experimental results agree well with Monte Carlo calculations, made for the identical conditions, and with the results of previous studies for thinner barriers. It was shown that the half width of the angular distribution of the electrons increases with the increase of the barrier thickness, reaches a point of constant value, and the distribution itself obeys the law of total diffusion, i.e., converts to a distribution similar to $\cos^2\theta$. With additional increase of the thickness of the absorber the half width is decreased and the distribution becomes very narrow which is explained by the penetration of electrons to large depths of the absorber. The predominant scattering is in the forward direction. (tr-auth)

# Atomic and Molecular Properties

**29305** (INIS-mf-1726) THE HELIUM ATOM AS A THREE-BODY PROBLEM. Calculation of the Energy of the Fundamental State. de Godoy Andrade, S. (Instituto de Fisica Teorica, Sao Paulo (Brazil)). 1973. 113p. (In Portuguese). INIS.

Hyperspherical harmonics (H. H.) are applied to the calculation of the energy of the fundamental state of the helium atom, this atom being considered as a three-body system interacting in pairs through the Coulomb force. A variational method is used, using a test function containing four H. H., as well as another containing six H. H. It is verified that the convergence in the energy values is slow, because in passing from the function with four H. H. to that with six H. H., a better energy sensitivity is not obtained. (auth)

**29306** CALCULATION OF THE HIGH FREQUENCY PART OF THE MAGNETIC SUSCEPTIBILITY OF MOLECULAR HYDROGEN. Walnut, T. H. (Syracuse Univ., N. Y. (USA). Dept. of Chemistry). Chem. Phys. Lett.; 33: No. 3, 593-595(15 Jun 1975).

The values of the magnetic susceptibility, the magnetic anisotropy and the high frequency part of the magnetic susceptibility for molecular hydrogen are calculated with greater combined accuracy than in previous calculations. The method used is a modification of the procedure of minimizing with respect to the gauge. (auth)

**29307** REGULARITIES IN STARK BROADENING PARAMETERS. Puric, J.; Cirkovic, L.; Labat, J. (Faculty of Sciences, Belgrade). Fizika (Zagreb); 6: No. 4, 211-217(Dec 1974).

Existence of regularities and systematic trends of Stark broadening parameters have been indicated using semiempirical formulae of Griem for width and shift of spectral lines. The relationship between Stark broadening parameters and nuclear charge was found and these regularities were illustrated by the experimental results for elements belonging to the second group of the periodic system. 23 refs, 2 figs. (auth)

**29308** HIGH TEMPERATURE VIBRATIONAL RELAXATION IN HD. Simpson, C. J. S. M.; Price, T. J.; Crowther, M. E. (Oxford Univ. (UK). Physical Chemistry Lab.). Chem. Phys. Lett.; 34: No. 1, 181-183(1 Jul 1975).

Measurements of the vibrational relaxation rate of an HD/Ar mixture in a shock tube suggest that HD vibrational relaxation is faster than that of $H_2$ or $D_2$. (auth)

# Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

*Refer also to abstracts 28643 and 29874.*

**29309** CONSERVING ORIENTATION TENSORS AND A POSSIBLE ANISOTROPY OF THE X-RAY RADIATION FROM MESIC ATOMS. Korenman, G. Ya. (Moscow State Univ.). Yadern. Fiz.; 21: No. 4, 772-780(Apr 1975). (In Russian).

Variation of the statistical tensors of the system subject to a cascade of transitions is considered in view of the problem of angular distribution of X-rays from mesic atoms. At the transition $J_0 \to J_1$ having the minimal angular momentum of the radiation ($L_1$ = absolute value of $(J_0 \to J_1)$) the orientation tensors (the statistical tensors, normalized in a certain way) of the rank $\kappa \leq \min(2J_0, 2J_1)$ remain unchanged. If for every transition in the cascade the relation $L_\nu = J_{\nu-1} - J_\nu$ is valid, the angular distribution of the radiation does not depend on presence of preceding transition and is determined only by the orientation tensors of the initial state (before the cascade) and by the multipolarity of the detected radiation. Applicability of these results to the cascade of radiative and Auger transition in mesic atoms is considered. It is shown that under certain assumptions on the mechanism of atomic capture of the mesons the angular distribution of the X-ray radiation from the mesic atoms has a considerable anisotropy related to direction of the primary meson beam. (auth)

**29310** QUANTUM ELECTRODYNAMICS: EXCITED STATE OF POSITRONIUM. Robinson, A. L. Science; 189: No. 4199, 276-277(25 Jul 1975).

An experiment to verify the existence of the first excited state of positronium is reported. A brief survey of events leading to the experiment is given and the experimental method is described. (GHT)

**29311** LEPTONIC PAIR PRODUCTION IN THE 2S–1S DECAY OF MESIC ATOMS. Grotch, H.; Kazes, E. (Pennsylvania State Univ., University Park). J. Phys., G (London); 1: No. 5, 579-583(20 Jun 1975).

The transition rate for leptonic pair production in the decay of the 2S state of high-Z mesic atoms is estimated. The electromagnetic decay to $e^+ e^-$ is much smaller than the M1 decay for high Z and is about 2% of the 2E1 decay. The decay into neutrino-antineutrino pairs, which could occur if neutral currents exist, is completely negligible in comparison to other decay processes. (auth)

**29312** INVESTIGATION OF DEFECTS IN METALS WITH POSITIVE MUONS. Seeger, A. (Max-Planck-Institut fuer Metallforschung, Stuttgart (F. R. Germany). Inst. fuer Physik). Phys. Lett., A; 53: No. 4, 324-326(30 Jun 1975).

It is shown that the trapping of positive muons by defects in metals attracting positively charged particles may be used to investigate such defects in considerable detail by spin relaxation of positive muons. (auth)

**29313** POSITRON ANNIHILATION IN GERMANIUM. Shulman, M. A.; Beardsley, G. M.; Berko, S. (Brandeis Univ., Waltham, Mass. (USA)). Appl. Phys.; 5: No. 4, 367-374(Jan 1975).

From 3rd international conference on positron annihilation; Otaniemi, Finland (7 Aug 1973). 5 figs.; 23 refs.

High precision long-slit and cross-slit geometry angular distributions of annihilation radiation from oriented germanium are presented. The momentum distributions from the long-slit measurements are compared with recent Compton profile data to test the importance of the positron wave function and positron-electron correlations. Evidence for Umklapp annihilation is discussed. No observable differences are found between distributions from heavily doped and intrinsic germanium samples. Differences in the angular distributions between 5 and 300 K are attributed to positron thermal motion, and the results are analyzed by a new method to obtain an estimate of the positron effective mass. (auth)

**29314** NEW FACTS ABOUT CHEMICAL REACTIONS OF THE POSITRONIUM ATOM. Ache, H. J. Nachr. Chem. Tech.; 87: No. 6, 108-110(Mar 1975). (In German).

Production and probability of the formation of positronium atoms ($e^+e^-$ or Ps), reactions of the ortho-Ps, electron transfer from Ps to the substrate molecule, i.e., oxidation of the Ps, a

clear diagram of the reactions of the o-Ps, the annihilation of the Ps through chemical compounds, reactions of so-called "hot" Ps atoms and the stability of the Ps complexes in solution are dealt with in a summary. (auth)

**29315** STRUCTURE OF POROUS VYCOR GLASS AND ITS ADSORPTION CHARACTERISTICS AND WATER. An Application of Positron Annihilation Method. Ito, Y. (Tokyo Univ. (Japan)); Yamashina, T.; Nagasaka, M. (Hokkaido Univ., Sapporo (Japan). Faculty of Engineering). Appl. Phys.; 6: No. 3, 323-326(Apr 1975).

Positron lifetimes in porous Vycor glass were measured. There are four lifetime components, and the fourth component was assigned to o-Ps annihilation in large pores of radius 34 Angstroem. The intensity $I_4$ was correlated to a specific surface area, but the value obtained from $I_4$ by the Monte Carlo method is smaller than that obtained by the BET method. From variations in lifetime and intensity against the kinetics of adsorption of water vapor, a rough picture of water adsorption is presented. (auth)

**29316** NEW EQUILIBRIUM EFFECT IN POSITRON TRAPPING IN METALS. Lichtenberger, P. C.; Schulte, C. W.; MacKenzie, I. K. (Guelph Univ., Ontario (Canada). Dept. of Physics). Appl. Phys.; 6: No. 3, 305-307(Apr 1975).

The equilibrium lineshape for positrons annihilating in Cd shows an anomalous temperature dependence which complicates analysis for vacancy formation energies. The phenomenon, tentatively identified as trapping by transient dilatations, probably occurs in all metals. (auth)

**29317** POSITRONIUM INTERACTIONS WITH GASES IN PORES OF SILICAGELS. Goldanskii, V. I.; Mokrushin, A. D.; Tatur, A. O.; Shantarovich, V. P. (AN SSSR, Moscow. Inst. Khimicheskoj Fiziki). Appl. Phys.; 5: No. 4, 379-382(Jan 1975).

From 3rd international conference on positron annihilation; Otaniemi, Finland (7 Aug 1973). 3 figs.; 1 tab.; 14 refs.

Positronium interaction with $O_2$, NO, $Cl_2$ molecules in pores of silicagels was investigated by the methods of lifetime and angular correlation. For silicagel with diameter of pores approximately 100 A it was found that the rate constant of positronium conversion on oxygen was $(2.4 \pm 0.2)10^7$ $sec^{-1}$ $atm^{-1}$ and on nitrogen oxide $(2.6 \pm 0.2)10^7$ $sec^{-1}$ $atm^{-1}$. The rate constant of the positronium chemical reaction with $Cl_2$ was found to be approximately $10^{-11}$ $sec^{-1}$ $atm^{-1}$. The results of investigation are explained in terms of the formation of an excited complex $PsO_2^*$. The decay of this complex to Ps and $O_2$ makes possible positronium conversion, and stabilization of the complex leads to annihilation in the bound state (chemical reaction). (auth)

**29318** POSITRONS IN ALKALI HALIDES. Nieminen, R. M. (Cambridge Univ., Eng.). J. Phys., C (London); 8: No. 13, 2077-2084(7 Jul 1975).

Proper symmetry wave functions for positrons in alkali halide crystals are calculated through a plane wave expansion. The band contributions to the effective masses are given. The anisotropies in the momentum distribution due to annihilations in the band states are examined, and the relative importance of anions and cations to annihilation events is assessed. The diffusion of positrons is discussed within a polaron picture, and some previously proposed models for the origin of the longer-lived lifetime component are dealt with. (auth)

## Collision Phenomena

*Refer also to abstracts 29310 and 29626.*

**29319** (JINR-7-7226) THE FORTRAN PROGRAMME FOR SOLUTION OF IONIZATION DIRECT PROBLEM AND CALCULATION RESULTS FOR THE ELEMENTS WITH Z = 6-10. Ilyushchenko, V. I.; Kochkin, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 16p. (In Russian). INIS.

9 refs.; 5 figs.

A FORTRAN program, "MOWGLI," was developed for a solution of the direct problem of successive ionization, i.e., for determination of concentrations of multi-charged ions, $q_i = q_i(t)$, where i is the charge and t is the time. The problem is solved for the initial conditions $q_i(0) = 1$, $\Sigma q_i(0) = 1$ for elements from carbon through neon. (tr-auth)

**29320** EXCITATION OF RESONANCE LEVELS OF ALKALI METAL ATOMS BY ELECTRON IMPACT. Zapesochnyi, I. P.; Postoi, E. N.; Aleksakhin, I. S. (Uzhgorod State Univ., USSR). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1724-1735(May 1975). (In Russian).

Detailed and reliable experimental investigations are carried out on the effective cross sections for excitation of resonance levels of alkali metal atoms by electrons with energies ranging from the process threshold up to 300 eV. The effective cross sections at the excitation peak vary between $4.9 \cdot 10^{-15}$ $cm^2$ for Li to $14.2 \cdot 10^{-15}$ $cm^2$ for Cs. For electron energies exceeding about 20 threshold units a satisfactory agreement between the first Born approximation calculations and experimental data is observed for all atoms; at low energies agreement is observed with calculations by the strong coupling method. (auth)

**29321** DIFFERENTIAL SCATTERING CROSS SECTIONS IN $K^+$-Ar COLLISIONS. Afrosimov, V. V.; Gordeev, Yu. S.; Lavrov, V. M. (Ioffe Physical-Technical Inst., Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1715-1723(May 1975). (In Russian).

Elastic and inelastic scattering in $K^+$-Ar collisions is studied in the 1 to 4 keV energy range. Angular dependences are measured of the cross sections for elastic scattering, excitation of the $K^+$ ion and Ar atom, charge exchange and autoionization of the Ar atom. The cross sections for inelastic processes strongly increase on attainment of the threshold angle and oscillate on further increase of the scattering angle. Comparison of the structures of the cross section angular dependences show that on excitation of some inelastic processes effects related to the interaction of inelastic channels are important. (auth)

**29322** CONTINUUM EXCHANGE INTEGRALS FOR ALGEBRAIC VARIATIONAL CALCULATIONS OF ELECTRON-ATOM SCATTERING USING SLATER-TYPE ORBITALS AS BASIS FUNCTIONS. Abdallah, J. Jr.; Truhlar, D. G. (Minnesota Univ., Minneapolis (USA). Dept. of Chemistry). Comput. Phys. Commun.; 9: No. 5, 327-336(May 1975).

The problem of electron scattering from atoms can be solved using algebraic variational methods. The program NETI computes the non-exchange integrals and the present adaptation NETI/ETI adds the facility to compute the two-electron free-free exchange integrals which are needed for algebraic variational scattering calculations including exchange when exponential-type functions and regular spherical Bessel functions are used as basis functions. The adapted program can be used to evaluate all the integrals needed for electron-atom scattering calculations by the standard algebraic variational methods using exponential-type functions and regular spherical Bessel functions as basis functions. The exchange integrals are evaluated using the procedures of Lyons and Nesbet with an improvement discussed in this article. In each case the subprogram XLN considers six available methods of computation and chooses the optimum one for the integral. The adaptation NETI/ETI uses subprograms of the previously published NETI package for parts of the calculations of the exchange integrals. (auth)

**29323** CROSS SECTIONS FOR H- FORMATION FROM H(2s) + Ar, Kr, AND Xe COLLISIONS. Olson, R. E. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Atomique). Nucl. Instrum. Methods; 126: No. 3, 467-468(15 Jun 1975).

Inelastic total cross sections for the reaction $H(2s) + X \rightarrow H^- + X^+$, where X ≡ Ar, Kr, and Xe, are calculated in the energy range 0.1-2.0 keV. (auth)

**29324** ENERGY TRANSFER DURING DISSOCIATIVE CHARGE-TRANSFER REACTIONS OF METHANE WITH $H_2^+$ AND $He^+$. Milner, R. G.; Parker, J. E. (Heriot-Watt Univ., Edinburgh (UK)). Int. J. Mass Spectrom. Ion Phys.; 17: No. 2, 185-194 (Jun 1975).

The near-adiabatic theory has been applied to interpret the dissociative charge-transfer reactions of methane with $H_2^+$ and $He^+$. The results are consistent with the proposition that the appearance potentials of the fragment ions correspond to electronic energy levels of the $CH_4^+$ ion. An internal energy distribution of the primary product $CH_4^+$ ion is obtained by plotting the relative abundance against the appearance potential for the various fragment ions. (auth)

**29325** DISSOCIATIVE IONIZATION OF $H_2$, $N_2$ AND CO BY ELECTRON IMPACT: MEASUREMENT OF KINETIC ENERGY, ANGULAR DISTRIBUTIONS, AND APPEARANCE POTENTIALS. Koellmann, K. (Hamburg Univ. (F. R. Germany). 1. Inst. fuer Experimentalphysik). Int. J. Mass Spectrom. Ion Phys.; 17: No. 3, 261-285(Jul 1975).

For investigating dissociative ionization processes induced by electron impact, an apparatus was constructed which enables the kinetic energy, angular distributions and appearance potentials of the observed ions to be measured. Special ion optics were designed in order to avoid kinetic energy discrimination effects. Kinetic energy and angular distributions of $H^+(H_2)$, $N^+(N_2)$, $O^+(CO)$ and $C^+(CO)$ ions and appearance potentials of $O^+(CO)$ and $C^+(CO)$ ions of given kinetic energies were measured. Reaction models are proposed and discussed in terms of potential energy curves by correlating them with the kinetic energy distributions and appearance potentials. In contrast to $H^+(H_2)$ and $N^+(N_2)$, the $O^+(CO)$ and $C^+(CO)$ angular distributions measured here cannot be interpreted by existing theories. (auth)

**29326** APPEARANCE POTENTIAL MEASUREMENTS USING ION CYCLOTRON RESONANCE SPECTROMETRY. Buttrill, S. E. Jr.; Magil, G. C. (Minnesota Univ., Minneapolis (USA). Dept. of Chemistry). Int. J. Mass Spectrom. Ion Phys.; 17: No. 3, 287-297(Jul 1975).

The errors introduced by the kinetic shift make it desirable to develop methods for utilizing ion cyclotron resonance (ICR) ionization efficiency curves to obtain accurate thresholds for ionic fragmentation processes. The inverse convolution procedure of Vogt and Pascual is tested and found to remove the effects of the high energy tail of the Maxwellian part of the electron energy distribution. New procedures for smoothing the ionization efficiency data and identifying the actual energy threshold are described and tested. The heat of formation of $C_3H_5^+$ from propylene and cyclopropane was found to be 225 ± 2 kcal $mol^{-1}$, in excellent agreement with other recent work. (auth)

**29327** INTEGRAL REPRESENTATION OF CLASSICAL S-MATRIX AND CONSTRUCTION OF NEW UNIFORM APPROXIMATIONS. Ovchinnikova, M. Ya. (Inst. of Chemical Physics, Moscow). Teor. Mat. Fiz.; 22: No. 3, 364-374(Mar 1975). (In Russian).

An integral representation of classical S-matrix for one-dimensional nonlinear nonstationary problem is rigorously deduced, which is valid for all values of quantum numbers, including small ones. Comparison of the quasiclassical results with the exact ones for the model of oscillator with the external forces makes it possible to estimate the error of the method of classical S-matrix and its uniform Eiry approximation. Possibilities of constructing new «uniform» approximations, which could be useful in many-dimensional problems of atomic collisions, are discussed. (auth)

**29328** IMPACT PARAMETER DEPENDENCE OF THE PROBABILITY FOR K-SHELL IONIZATION BY NUCLEI. Kaminskii, A. K.; Nikolaev, V. S.; Popova, M. I. (Moskovskij Gosudarstvennyj Univ. (USSR). Inst. Yadernoj Fiziki). Phys. Lett., A; 53: No. 5, 419-420(14 Jul 1975).

The probability W for the atomic ionization by nuclei as a function of the impact parameter x is expressed through the ionization matrix element M. Values of W(x) for K-shell ionization calculated with the first Born M are compared with the experimental data and other calculations. (auth)

**29329** COMPLEX FORMATION IN REACTIVE AND INELASTIC SCATTERING: STATISTICAL ADIABATIC CHANNEL MODEL OF UNIMOLECULAR PROCESSES. III. Quack, M.; Troe, J. (Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Chimie Physique). Ber. Bunsenges. Phys. Chem.; 79: No. 2, 170-183(Feb 1975).

18 figs.; 2 tabs.; 68 refs.

The statistical adiabatic channel model for unimolecular dissociation reactions is extended to describe bimolecular collisions proceeding via a strongly bound intermediate complex. As examples three cases are considered, in which the intermediate complex corresponds to a known stable molecule: O + $O_2$ reversible $O^*_3$, O + NO reversible $NO^*_2$ and Cl + NO reversible $ClNO^*$. Using known molecular properties and the experimental high pressure recombination rate constants, the specific dissociation rate constants k(E,J), state to state inelastic scattering cross sections sigma(v,j → v',j') and center of mass translational energy distributions are calculated with the same simple potential model. Rate constants $k_{v\to v'}$ for vibrational relaxation are computed and found to be in good agreement with experimental results available for the O + $O_2$ vibrational relaxation. The dependence of cross sections and final state distributions as a function of initial state is illustrated in some detail. (auth)

**29330** EXCITATION CROSS-SECTIONS OF SODIUM FOR ELECTRON IMPACT MEASURED AT LOW DENSITIES. Pohl, J. (Kiel Univ. (F. R. Germany). Inst. fuer Experimentalphysik). Z. Phys., A; 273: No. 1, 19-21(May 1975). (In German).

2 figs.; 6 refs.

In a crossed-beam experiment Na atoms are excited by electrons with an energy of 11 eV. For particle densities between $2 \times 10^{11}$ $cm^{-3}$ and $5 \times 10^{7}$ $cm^{-3}$ the measured excitation cross section of the Na-D-lines increases with decreasing density. Several experiments are described confirming this unexpected effect. (auth)

**29331** EXCITATION OF PROJECTILE RYDBERG STATES IN THE COLLISIONS $Be^+$–He AND $Mg^+$–He, 10 to 75 keV. Andersen, N.; Jensen, K.; Jepsen, J.; Melskens, J.; Veje, E. (Copenhagen Univ. (Denmark). H. C. Oersted Inst.). Z. Phys., A; 273: No. 1, 1-8(May 1975).

5 figs.; 3 tabs.; 11 refs.

The collisions $Be^+$–He and $Mg^+$–He were studied from 10 to 75 keV by means of optical spectrometry. Relative excitation cross sections and polarizations were measured at 40 keV for S through G terms with principal quantum number n up to 10. Within a Rydberg series the excitation cross sections are found to decrease monotonically with n, and the excited terms have in general a negative alignment. (auth)

**29332** ABSOLUTE MEASUREMENTS OF THE ELECTRON-ARGON ATOM TOTAL IONIZATION CROSS SECTION. Kurepa, M. V.; Cadez, I. M.; Pejcev, V. M. (Inst. of Physics, Belgrade). Fizika (Zagreb); 6: No. 4, 185-209(Dec 1974).

Total electron impact ionization cross sections for the argon atom in the energy range from 19–200 eV have been measured. Very careful target gas pressure and temperature, as well as collection length calibrations have been done. The results obtained are in agreement with data of Rapp and Englander Golden. The analysis of all possible sources of errors in presented and their contributions determined. 6 figs., 24 refs. (auth)

**29333** ANGULAR DISTRIBUTION OF ELECTRONS EJECTED BY CHARGED PARTICLES. IV. Combined classical and Quantum-Mechanical Treatment. Boesten, L. G. J. (Rijksuniversiteit Utrecht (Netherlands). Fysisch Lab.); Bonsen, T. F. M. (Moller Instituut, Tilburg, The Netherlands). Physica; 79: No. 3, 292-302(1975).

Angular distributions of electrons ejected from helium by 100 and 300 keV protons have been calculated by a method which is a combination of the classical three-body collision theory and the quantum-mechanical Born approximation. The results of this theory have been compared with the corresponding experimental data and results of the Born and the classical three-body collision theories. The results of the combined method are in close agreement with the experimental data over the whole range of the ejection angles. (auth)

**29334** COLLISION STRENGTHS FOR FORBIDDEN N II, O III, Ne II, AND Ne III. Seaton, M. J. Mon. Not. R. Astron. Soc.; 170: 475-486(1975).

The results of some recent collision strength calculations are given in a form convenient for the interpretation of observations. The calculations are estimated to be accurate within 10 percent based on: comparison of observed and calculated energies for the bound states of the (electron + ion) systems. Semi-empirical corrections are made for forbidden Ne II; comparisons of calculated positions obtained from iso-electronic sequence extrapolations. This of particular importance for forbidden O III; and the convergence of the expansions used for the wave functions, in particular for forbidden N II and Ne III, where inclusion of additional states produces only small changes in the near-threshold results. (IAA)

**29335** TRAJECTORY CALCULATIONS FOR THE REACTION $H_3^+ + He \rightarrow H + HeH^+$. Kuntz, P. J.; Whitton, W. N. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F. R. Germany). Sektor Strahlenchemie). Chem. Phys. Lett.; 34: No. 2, 340-342(15 Jul 1975).

Using classical trajectory methods and a diatomics-in-molecules representation of an ab initio potential function, it is shown that $H_3^+$ vibrational energy is far more effective than the equivalent amount of relative kinetic energy in promoting this endothermic reaction. This result is in sharp contrast to previous (quantum mechanical) collinear results and is in good agreement with experiment. (auth)

**29336** SEMI-CLASSICAL CALCULATIONS OF ROTATIONAL/VIBRATIONAL TRANSITIONS IN He-$H_2$. Billing, G. D. (Copenhagen Univ. (Denmark). H. C. Oersted Inst.). Chem. Phys. (Amsterdam); 9: No. 3, 359-369(Jul 1975).

The applicability of the classical trajectory equations in three-dimensional calculations of rot/vib transitions in the He-$H_2$ system was investigated. The vibrational relaxation time is calculated and the agreement with experimental data is excellent for temperatures above 250 K. The method has been used to determine the differential cross-sections for vib/rot excitation at 1.09 eV total energy and comparison is made with recent quantum mechanical effective potential calculations. (auth)

**29337** TESTS OF SEMICLASSICAL TREATMENTS OF VIBRATIONAL-TRANSITIONAL ENERGY TRANSFER IN COLLINEAR COLLISIONS OF HELIUM WITH HYDROGEN MOLECULES. Duff, J. W.; Truhlar, D. G. (Minnesota Univ., Minneapolis (USA). Dept. of Chemistry). Chem. Phys. (Amsterdam); 9: No. 3, 243-273 (Jul 1975).

Three kinds of semiclassical theory are tested against quantum mechanical results for vibrational transition probabilities and average vibrational energy transfers in collinear collisions of atoms with harmonic and Morse vibrators for the He-$H_2$ mass combination. The interaction potential is assumed to be a repulsive exponential function with an exponential parameter which is realistic for He-$H_2$ collisions. The energy range studied is total energies of 2 to 8 in units of $\hbar\omega_0$. The uniform semiclassical approximation of classical S matrix theory is tested only for

classically allowed transitions, i.e., for transition probabilities greater than about 0.2. They are accurate quantitatively for both harmonic and Morse vibrators. The integral expressions of classical S matrix theory are found to be quantitatively accurate for classically allowed and weakly classically forbidden transitions, i.e., for transition probabilities greater than about 0.01 to 0.05, and to be unreliable for strongly classically forbidden transitions. Quasiclassical trajectory methods yield qualitatively accurate results only for classically allowed transitions but the phase-averaged energy transfer in quasiclassical collisions may be accurate even when classically forbidden transition probabilities are important for the calculation of the average energy transfer. Forced quantum oscillator methods using a classical path whose initial velocity is the average of the initial and final velocities corresponding to the transition of interest are accurate for transition probabilities as small as $4 \times 10^{-6}$ for harmonic vibrators but do not seem to accurately account for the effect of anharmonicity. (auth)

## Atomic Theory

**29338** (CONF-730750-, pp G1-G10) NUCLEAR AND ATOMIC SHELL THEORY. de Wet, J. A. Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

Particle-like representations of the complete homogeneous Lorentz group are considered in relation to modern shell theory. (JFP)

**29339** THE EFFECT OF THE FINE STRUCTURE TERMS ON THE SUPERHYPERFINE STRUCTURE OF THE EPR SPECTRA. Lupei, V.; Lupei, A. (Institutul de Fizica Atomica, Bucharest (Romania)). pp 175-176 of Magnetic Resonance and Related Phenomena. Vol. I. Allen, P. S. (ed.). Amsterdam; North Holland Publishing Co. (1975).

From 18th ampere congress on magnetic resonance and related phenomena; Nottingham, Eng. (9 Sep 1974).

The eigenvalue and eigenfunction problems for the hyperfine and superhyperfine interaction in the frame of the spin-Hamiltonian formalism are essentially the same. A difference may appear due to the fact that, while in the first case the nuclear Zeeman interaction plays a minor role, in the second, due to the small value of the superhyperfine structure parameters, the nuclear Zeeman term becomes important. The problem can be solved using the effective field method. For the effective field the sum of the hyperfine effective field and the external magnetic field is taken. For the sake of simplicity a paramagnetic ion in an axial crystalline field having a superhyperfine structure with one ligand placed on the symmetry axis of the crystal field is considered. (auth)

**29340** MECHANISMS OF SPIN TRANSMISSION: ISOTROPIC HYPERFINE INTERACTIONS. Marcellus, D. H.; Davidson, E. R.; Kwiram, A. L. (Washington Univ., Seattle (USA). Dept. of Chemistry). Chem Phys. Lett.; 33: No. 3, 522-527(15 Jun 1975).

The contributions of spin delocalization mechanisms to the proton hyperfine coupling constant is investigated. It is shown that these non-observables are not uniquely defined in most calculations. Arguments are presented which suggest that these non-observables may be profitably defined if both unrestricted Hartree-Fock and restricted Hartree-Fock calculations are made. (auth)

**29341** THIRD ORDER ELECTRIC POLARIZABILITIES OF THE $H_2$-MOLECULE AND C-C AND C-H SIGMA-BONDS. Flytzanis, Chr. (Ecole Polytechnique, 75 - Paris (France)). Chem. Phys. Lett.; 33: No. 3, 555-559(15 Jun 1975).

The third order electric polarizability $\gamma$ of the $H_2$-molecule and of C-C and C-H $\sigma$-type bonds in calculated using a variational-perturbation procedure; the sign, magnitude and anisotropy of $\gamma$ are given. In the case of the $H_2$-molecule the influence of the choice of the wavefunction on the value of $\gamma$ is discussed. (auth)

**29342** A SIMPLE VARIATIONAL-PERTURBATIONAL APPROACH TO THE CORRELATION PROBLEM IN ATOMS AND MOLECULES. Cederbaum, L. S.; Schoenhammer, K.; Niessen, W. von (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.). Chem. Phys. Lett.; 34: No. 2, 392-394(15 Jul 1975).

A simple statement for the ground state of atoms and molecules is proposed which is also suitable for large internuclear distances where perturbation theory breaks down. In its simplest form, where only doubly-excited configurations are included, the statement leads to 97.3% of the exact correlation energy of $H_2O$ calculated in the doubly-excited configurational space with the same basis set. The calculated correlation energy for $N_2$ shows the correct behaviour as a function of internuclear distance. (auth)

**29343** PSEUDOPOTENTIALS IN ATOMIC AND MOLECULAR PHYSICS. Bardsley, J. N. (Pittsburgh Univ., Pa. (USA). Dept. of Physics). Case Stud. At. Phys.; 4: No. 5, 299-368(Jun 1974).

183 refs.

The pseudopotential concept was introduced into the solution of many-body problems in solid-state physics, quantum chemistry and atomic physics. The formal development of pseudopotential theory is reviewed. The technique for obtaining pseudopotentials is described and the ab initio and semi-empirical approaches are contrasted. Applications of the method to problems involving atoms and small molecules are discussed, and some new results are presented. These applications include studies of atomic electron affinities, interatomic potentials and electron scattering by atoms. (auth)

# PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

**29344** THEORETICAL INVESTIGATION OF BOUND ROTON PAIRS IN SUPERFLUID $^4$He. Cheng, S. T. Denton, TX; North Texas State University (1974). 175p. University Microfilms Order No. 75-7032.

Thesis (Ph. D.).

The Bogoliubov theory of excitations in superfluid helium is used to study collective modes at zero temperature. A repulsive delta function shell potential is used in the quasi-particle excitation energy spectrum to fit the observed elementary excitation spectrum, except in the plateau region. The linearized equation of motion method is used to obtain the secular equation for a collective mode consisting of a linear combination of one and two free quasiparticles of zero total momentum. It is shown that in this case for high-lying collective modes, vertices involving three quasiparticles cancel, and only vertices involving four quasiparticles are important. A decomposition into various angular momentum states is then made. Bound roton pairs in the angular momentum D-state observed in light-scattering experiments exist only for an attractive coupling between helium atoms in this oversimplified model. Thus, the interaction between particles can be reinterpreted as a phenomenological attractive coupling between quasiparticles, in order to explain the Raman scattering from bound roton pairs in superfluid helium. (auth)

**29345** ATTEMPT TO IMAGE AND PHOTOGRAPH AN ARRAY OF QUANTIZED VORTEX LINES IN ROTATING SUPERFLUID HELIUM. Maynard, J. D. Jr. Princeton, NJ; Princeton University (1974). 79p. University Microfilms Order No. 75-6701.

Thesis (Ph. D.).

The design of and experiments with a device to image and photograph the array of quantized vortices in rotating superfluid helium are described. Some theoretical background of vortices in helium is given, and a few previously attempted methods of imaging the array are discussed. The method used in this experiment involves the trapping of negative ions produced by an alpha source onto the vortex lines, resulting in an array of current filaments in the liquid helium. These current filaments terminate on a wire array (a close-packed bundle of fine, insulated copper wires) which acts like a fiber optics faceplate. On the opposite side of the wire array, the negative ions are ejected by ultraviolet light into a high vacuum region, where they are accelerated and focused by electric and magnetic fields onto a phosphor screen. The image on the phosphor screen is transmitted by a coherent fiber optics light pipe to an image intensifier and camera system. Resolution (60 points/mm$^2$) and sensitivity (400 ions/sec/live) are sufficient to show the vortex array if stabilized. When rotated with superfluid helium, the device shows a uniform image of the wire array. A discussion of the results and possible improvements of the experiment are given. (auth)

**29346** SUPERFLUID FILM PHENOMENA. Flint, E. B. Amherst, MA; University of Massachusetts (1974). 143p. University Microfilms Order No. 75-6024.

Thesis (Ph. D.).

Experiments have been performed which study the helium film flow oscillations which exist between two film coupled reservoirs. The film oscillations were monitored using a three terminal capacitance technique which measured the level in one reservoir as a function of time. These studies may be separated into two groups: 1. experiments that studied the frequency and decay constant that describe the film oscillations and, 2. experiments that studied the velocity dependence of the film thickness. (Diss. Abstr. Int., B)

**29347** MICROSCOPIC THEORY OF COLLECTIVE MODES IN AN INTERACTING BOSE GAS AT FINITE TEMPERATURES. Cheung, T. H. Toronto; Toronto University (1971). 89p. National Library of Canada, Ottawa.

Thesis (Ph. D.).

The thermodynamic Green's function technique is used to study the elementary excitation spectrum and density fluctuation spectrum in a weakly interacting Bose gas. The shielded potential approximation for the single-particle Green's function generalizes Bogoliubov's simple theory by replacing the bare interaction by a dynamically shielded interaction and thus includes the effect of the excited atoms. A temperature-dependent correction to the Bogoliubov phonon velocity is obtained. Evidence is obtained for the existence of a second elementary excitation at higher temperatures. Two methods of calculating the density-density correlation function are then considered. The density-density correlation function $S(k,\omega)$ is calculated in a way which is consistent with the approximation made for the single particle Green's function. (auth)

**29348** CONTROVERSY OVER AN ALIGNED MAGNETIC FIELD. Ludford, G. S. S. (Cornell Univ., Ithaca, NY). Proc. Symp. Appl. Math.; 18: 57-63(Apr 1967).

The steady motion of a perfectly conducting inviscid liquid past a thin symmetric airfoil of finite conductivity, with the ambient magnetic field being aligned with the free stream is considered. (auth)

**29349** MAGNETIC TEXTURES IN SUPERFLUID $^3$He B. Ahonen, A. I.; Alvesalo, T. A.; Haikala, M. T.; Krusius, M.; Paalanen, M. A. (Helsinki Univ. of Tech., Otaniemi, Finland). J. Phys., C (London); 8: No. 12, L269-L274(21 Jun 1975).

Magnetic anisotropy effects have been studied in $^3$He B with transverse NMR on liquid confined into 0.4 mm wide slits between flat parallel foils. The results have been fitted to recent theories on orientational effects in dynamic magnetism. (auth)

**29350** SPIN DIFFUSION IN $^3$He-$^4$He MIXTURES NEAR THE LAMBDA LINE. Lucas, P.; Penman, D. A.; Tyler, A. (Manchester Univ. (UK)). Phys. Lett., A; 53: No. 6, 453-454(28 Jul 1975).

High resolution measurements of the temperature dependence of the spin diffusion coefficient of $^3$He in liquid helium isotopic mixtures near the superfluid transition temperature are presented in order to examine the possibility of a weak singularity in this transport process. (auth)

# PHYSICS (HIGH-ENERGY)

## Particle Interactions and Properties (Experimental)

**29351** (INIS-mf-1739, pp 532-556) AN EXPERIMENTAL REVIEW OF LARGE TRANSVERSE MOMENTUM PHENOMENA. Smith, A. M. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4–10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

Large transverse momenta are considered to mean the region where the $e^{-6p_\perp}$ distribution no longer holds. Single particle inclusive distributions, particle ratio, and correlations involving a large $p_\perp$ particle are discussed and compared in detail. (auth)

### *Electromagnetic*

*Refer also to abstract 30093.*

**29352** ELASTIC SCATTERING OF PHOTON BY PROTONS IN THE LOW ENERGY REGION. Baranov, P. S.; Buinov, G. M.; Godin, V. G.; Kuznetsova, V. A.; Petrun'kin, V. A.; Tatarinskaya, L. S.; Shirchenko, V. S.; Shtarkov, L. N.; Yurchenko, V. V.; Yanulis, Yu. P. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 21: No. 4, 689-698(Apr 1975). (In Russian).

The differential cross section of the elastic scattering of photons by protons is measured in the energy range from 70 to 110 MeV at 90 and 150° laboratory angles. The data on the monitor process $\gamma + e \rightarrow \gamma' + e'$ obtained by means of the same set-up were used to determine the absolute values of the cross section of the reaction $\gamma + p \rightarrow \gamma' + p'$. Approximating the experimental values of the photon-proton elastic scattering cross section by a phenomenological expression for low energies we find the coefficients of the proton electric and magnetic polarizability: $\alpha_p = (10.7 \pm 1.1) \cdot 10^{-43}$ cm$^3$; $\beta_p = (-7.0 \pm 1.6) \cdot 10^{-43}$ cm$^3$. (2 figures, 2 tables) (auth)

**29353** SEARCH FOR CHARGE ASYMMETRY IN ELECTROMAGNETIC INTERACTIONS OF COSMIC RAY MUONS WITH IRON. Magnuson, C. E. College Station, TX; Texas A and M University (1974). 237p. University Microfilms Order No. 75-15,044.

Thesis (Ph. D.).

A search for charge asymmetry in electromagnetic interactions of cosmic ray muons with iron has been conducted using a wide-gap spark chamber cosmic ray spectrometer. The measurements cover a momentum range from 2 GeV/c to about 200 GeV/c and zenith angles from 50 to 90° and include 12,309 events. The total charge asymmetry at large zenith angles is $1.019 \pm 0.041$. This value does not support the idea that there is a charge asymmetry. (auth)

**29354** MODELING OF INTERACTION BETWEEN A PLANE ELECTRON BEAM AND A TRAVELING WAVE IN CROSSED FIELDS. Romanov, P. V.; Roshal, A. S.; Yankelevich, P. Sh. Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 18: No. 4, 588-596(1975). (In Russian).

The interaction between an electron beam and a traveling wave in crossed fields has been analysed by mathematical modelling method. Optimal sizes of a grid used in the solution of the Poisson equation a time step of modelling and the charge of a "large" electron are chosen. The results of calculations are given. (auth)

**29355** NONPERTURBATIVE APPROACH TO THE PROBLEM $\pi^0 \rightarrow 2\gamma$. Mukhopadhyay, P. (Jadavpur Univ., Calcutta (India). Dept. of Physics). Z. Naturforsch., a; 30: No. 5, 601-605(May 1975).

The question of the asymptotic conformal invariance of the off-shell amplitude for the process $\pi^0 \rightarrow 2\gamma$ was investigated. It was shown that the off-shell amplitude for the process concerned can be given an asymptotically conformal covariant form by using a parton model description of the neutral pion instead of treating the pion as an elementary particle. This investigation shows that the conclusion regarding the question of the asymptotic conformal invariance of the off-shell amplitude for the process $\pi^0 \rightarrow 2\gamma$ obtained from the parton model along with the use of conformal covariant operator product expansions is the same as that of the Johnson-Baker-Willey version of finite QED from which the asymptotic conformal invariance of the 3-point Green's function for the process $\pi^0 \rightarrow 2\gamma$ follows as a necessary consequence. (auth)

**29356** EXPERIMENTAL STUDY OF ACOPLANAR ($\mu^+\mu^-$) PAIRS PRODUCED IN ($e^+e^-$) ANNIHILATION. Bollini, D.; Giusti, P.; Massam, T.; Monari, L.; Palmonari, F.; Valenti, G.; Zichichi, A. (Univ., Bologna). Lett. Nuovo Cim.; 13: No. 10, 380-382(5 Jul 1975).

The reaction $e^+e^- \rightarrow \mu^+\mu^-$ has been studied to establish the existence of acoplanar $\mu^+\mu^-$ pairs. In the energy range 0.6 to 1.5 GeV, a total of 54 acoplanar pairs were observed compared to 1567 coplanar pairs in the same energy interval. The observation of acoplanar pairs is a further proof of the electromagnetic equivalence between the muons and the electrons in third order QED time-like processes. (2 figures, 1 table) (SDF)

**29357** ELECTROMAGNETIC FORM FACTORS OF THE PROTON AT LOW FOUR-MOMENTUM TRANSFER (II). Borkowski, F.; Simon, G. G.; Walther, V. H.; Wendling, R. D. (Mainz Univ. (F. R. Germany). Inst. fuer Kernphysik). Nucl. Phys., B; 93: No. 3, 461-478(28 Jul 1975).

The 300-MeV electron linear accelerator at Mainz was used to measure the angular dependence of the electron-proton elastic scattering cross sections at seven different energies for squared four-momentum transfers between 0.13 and 4.7 fm$^{-2}$. The proton form factors were extracted from the cross sections by means of Rosenbluth plots and by fitting parametrized analytical functions directly to the cross sections. The best fit is compared to the data of other laboratories. The previously reported deviations from the dipole fit were confirmed. From the form factors at $q^2 < 0.9$ fm$^2$ the proton r.m.s. radius was determined. A determination of the spectral function of the nucleon isovector form factor $G_E^V$ in the time-like region is obtained using a realistic $\rho$ resonance. (auth)

**29358** MEASUREMENT OF THE LONGITUDINAL AND TRANSVERSE PARTS OF THE $\pi^+$ ELECTROPRODUCTION CROSS-SECTION AT 1175 MeV PION–NUCLEON CENTER-OF-MASS ENERGY. Bardin, G. (CEN de Saclay, Gif-sur-Yvette, France); Duclos, J.; Julien, J.; Magnon, A.; Michel, B.; Montret, J. C. Lett. Nuovo Cim.; 13: No. 13, 485-488(26 Jul 1975).

The case is considered in which a pion produced in an $e^-p$ interaction is emitted in the direction of the virtual photon. The photoproduction cross section may then be split into transverse (T) and longitudinal (L) components. A preliminary measurement of T and L has been made for the electroproduction of positive pions at 1175 MeV to check pion exchange considerations. Dominance of the L component confirms that, in these kinematics, the reaction is dominated by the pion exchange mechanism. (SDF)

### *Weak*

**29359** SEARCH FOR $\Delta S = 2$ DECAYS OF NEUTRAL $\Xi$-HYPERONS. Geweniger, C.; Gjesdal, S.; Presser, G.; Steffen, P.; Steinberger, J.; Vanucci, F.; Wahl, H. (European Organization for Nuclear Research Geneva (Switzerland)); Eisele, F.; Kleinknecht, K.; Lueth, V. Phys. Lett., B; 57: No. 2, 193-196(23 Jun 1975).

A search for the decay $\Xi^0 \rightarrow p\pi^-$ has been performed in a neutral hyperon beam derived from the 24 GeV/c external proton beam at CERN. The experiment gives as a 90% confidence upper limit for the branching ratio Gamma$(\Xi^0 \rightarrow p\pi^-)$/Gamma$(\Xi^0 \rightarrow \Lambda\pi^0) < 3.6 \times 10^{-5}$. (auth)

**29360** RANGE AND MULTIPLE SCATTERING MEASUREMENTS OF LOW-ENERGY MUONS-REANALYSIS. Lagerlund, T. D.; Blecher, M.; Gotow, K.; Lam, W. C. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Nucl. Instrum. Methods; 127: No. 1, 145(15 Jul 1975).

The multiple scattering of low energy muons from foils of $CH_2$, Al, and galvanized Fe was measured. The data are compared with theory. (auth)

**29361** NEUTRAL KAON REGENERATION ON CARBON IN A MOMENTUM REGION OF 16-40GeV/c. Albrecht, K. F.; Birculev, V. K.; Deak, F.; Genchev, V. I.; Grigalashvili, T. S.; Gus'kov, B. N.; Hladky, J.; Ivanchenko, I. M.; Kekelidze, V. D.; Kiss, D. Nucl. Phys., B; 93: No. 2, 237-241(21 Jun 1975).

The modulus and the phase of the $K_1^0$–$K_S^0$ regeneration amplitude on carbon were measured. In a momentum range of 16 to 40 GeV/c the phase is constant within experimental error bars and coincides with the regeneration phase on hydrogen. Both the modulus and the phase of the regeneration amplitude on carbon are in agreement with optical model predictions. (auth)

## Strong (Baryon-induced)

*Refer also to abstracts 28989 and 29692.*

**29362** (CERN-75-10) MEASUREMENT OF THE REAL PART OF THE FORWARD SCATTERING AMPLITUDE BY MEANS OF THE COULOMB-NUCLEAR INTERFERENCE IN $\pi^{\pm}p$ AND $K^{\pm}p$ ELASTIC SCATTERING AT INCIDENT MOMENTA BELOW 3 GeV/c. Baillon, P.; Bricman, C.; Ferro-Luzzi, M.; Jenni, P.; Perreau, J. M.; Tripp, R. D.; Ypsilantis, T.; Declais, Y.; Seguinot, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 9 Sep 1975. 155p. Dep. NTIS (US Sales Only) $10.75.

The differential cross sections for $\pi^+p$ elastic scattering at 0.6, 1.0, 1.5, 2.0 GeV/c, for $\pi^-p$ at 1.0, 1.5, 2.0 GeV/c, for $K^+p$ at 1.2, 1.8, 2.6 GeV/c and for $K^-p$ at 0.9, 1.2, 1.4, 1.6, 1.8, 2.6 GeV/c were measured with an overall accuracy of the order of 1 to 2% in a counter experiment over the angular region corresponding to momentum transfers t between 0.0005 and 0.10 $GeV^2$. Making use of the interference effects between the Coulomb and the nuclear interaction, a determination was done of the magnitude and sign of the real part of the scattering amplitude near t = 0. The $\pi p$ real parts are compared to the values predicted by the dispersion relations and found to agree quite well. The $K^{\pm}p$ real parts were used in a dispersion relation to derive the value of the KNA coupling constant. Two possible values of this coupling constant are found, both much larger than those commonly accepted. One of them agrees well with the value predicted by the SU(3) and SU(6) symmetry schemes. (auth)

**29363** (COO-2009-107) TECHNICAL PROGRESS REPORT OF THE INDIANA UNIVERSITY SPARK CHAMBER GROUP, December 1, 1974-November 30, 1975. Brabson, B. B.; Crittenden, R. R.; Dzierba, A. R.; Heinz, R. M.; Neal, H. A. (Indiana Univ., Bloomington (USA)). 1975. 14p. Dep. NTIS $4.00.

During the present contract year the Indiana University High Energy Physics Group completed two proton-proton polarization experiments at the Argonne ZGS accelerator and an exotics search experiment at the Stanford Linear Accelerator Center. In addition substantial efforts were directed toward preparations for experiments at the Fermi National Accelerator Laboratory to study large p/sub T/ phenomena and polarization phenomena in elastic and inclusive p-p reactions and toward preparations for an experiment at the CERN SPS to study backward pion-proton elastic scattering. (auth)

**29364** (INIS-mf-1739, pp 493-512) MULTIPLICITY IN PROTON-NUCLEUS COLLISIONS AT 200 GeV/c AND MODELS OF MULTIPARTICLE PRODUCTION. Gurtu, A.; Malhotra, P. K.; Mittra, I. S.; Sood, P. M.; Gupta, S. C.; Gupta, V. K.; Kaul, G. L.; Mangotra, L. K.; Prakash, Y.; Rao, N. K. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, Jun 4-10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

Proton-nucleus collisions were studied using an emulsion exposure to the 200-GeV/c proton beam at the NAL. The details would be published in Pramana. Results are presented on multiplicity in proton-emulsion collisions at 200 GeV/c and the available data are analyzed in the range of 7.1 to 8000 GeV/c to draw conclusions on models of multiparticle production. (auth)

**29365** (JINR-R-1-8153) RESEARCH PROSPECTS ON HYPERON PHYSICS AND ON MULTIBARYONIC RESONANCES IN COLLISIONS OF RELATIVISTIC NUCLEI. Shakhbazyan, B. A.; Temnikov, P. P.; Timonia, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 15p. (In Russian). INIS.

9 refs.; 7 tables.

Production cross sections for hyperons in collisions with relativistic nuclei at synchrophasatron and nucleotron energies (5.5 and 25 GeV/nucleon, respectively) were calculated. Possibilities of studying hyperon physics and multibaryon resonances were considered. Actual experiments were calculated. (tr-auth)

**29366** (LNF-75/8(R)) PROPOSAL FOR THE MEASUREMENT OF THE PROTON ELECTRIC AND MAGNETIC POLARIZABILITIES. Matone, G.; Prosperi, D. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 13 Feb 1975. 19p. Dep. NTIS (US Sales Only) $4.00.

The experimental information now available on the proton polarizabilities is analyzed briefly; and a new, precise determination of both parameters is proposed. The cross section for photon Compton scattering is discussed first. Current knowledge on proton electric and magnetic polarizabilities is examined, and it is concluded that the situation is so confused that new experimental data are seriously needed. Finally, the possibilities offered by a monochromatic, plane-polarized photon beam are considered; the experimental setup, counting rates, and background are treated. (6 figures) (RWR)

**29367** CHARACTER OF CORRELATIONS BETWEEN THE MEAN NUMBERS OF NEUTRAL AND CHARGED PARTICLES IN MULTIPLE PRODUCTION PROCESSES AT ANNIHILATION AND COLLISIONS. Arestov, Yu. I.; Sulyaev, R. M. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 21: No. 4, 836-840(Apr 1975). (In Russian).

The quantity $n_0$ avg.$\Omega_1$ is studied-the mean number of $\pi^0$, produced at fixed values of $n_{-1}$ and Q, where Q is the invariant mass of the pions produced in the reactions anti p-p → pions and pp → NN + pions. Under some general assumptions it is proved that in spite of a decrease of the function $n_0$ avg.$\Omega_1$ with rising $n_{-1}$, the integration over Q leads to an increase of function. Important properties of the spectrum $d\sigma/dQ$ are found in the framework of the multi-reggeon model. Satisfactory results are obtained in fitting of the experimental data at 19, 70, 205, 303, and 1500 GeV/c. (1 table, 3 figures) (auth)

**29368** ORDERED RAPIDITIES IN PROTON-NUCLEON INTERACTIONS WITH SMALL MULTIPLICITY AND INCOHERENT PROTON-NUCLEAR INTERACTIONS AT 200 GeV. Adamovich, M. I.; Dobrotin, N. A.; Larionova, V. G.; Kharlamov, S. P.; Tret'yakova, M. I.; Chernyavskii, M. M. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 21: No. 4, 805-810(Apr 1975). (In Russian).

The experimental distributions of the ordered rapidities of the charged secondary particles in the pp interactions with the multiplicities of 2, 4, 6, 8 and in the protonnuclear interactions with 1, 3, 5 and 7 relativistic charged particles are presented. The results for the pp interactions are compared with predictions of the model of independent generation of particles with a homogeneous rapidity density. The distributions of the corresponding densities for the eight-prong events of pp interactions coincide with those for the seven-prong events of pn interactions. The rapidity distributions are determined for the coherent proton-nuclear interactions with n = 1, 3 and 5. They occupy a half of the possible interval of rapidities which correspond to the front hemisphere of the c. m. angular distribution of particles. (1 table, 5 figures) (auth)

**29369** CROSS SECTIONS FOR THE PRODUCTION OF Li AND Be ISOTOPES IN CARBON TARGEST IRRADIATED BY 300 GeV PROTONS. Raisbeck, G. M.; Lestringuez, J.; Yiou, F. (Centre National de la Recherche Scientifique, 91 - Orsay (France). Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse). Phys. Lett., B; 57: No. 2, 186-188(23 Jun 1975).

Cross sections for the production of Li and Be isotopes in carbon targets irradiated by 300 GeV protons have been measured by mass spectrometry. The results are compared with lower energy measurements and discussed in terms of the variation of the cosmic ray L/M ratio in this energy region. (auth)

**29370** SEARCH FOR SUBSTRUCTURE IN $\bar{p}p$ TOTAL CROSS SECTION IN THE 2200 MeV MASS REGION. Peaslee, D. C. (Australian National Univ., Canberra); DeMarzo, C.; Guerriero, L.; Posa, F.; Vaccari, E.; Waldner, F. (Bari Univ. (Italy). Istituto di Fisica); Lanou, R. E. Jr.; Massimo, J. T.; Thornton, R. K. (Brown Univ., Providence, R. I. (USA). Dept. of Physics); Aitkenhead, W. Phys. Lett., B; 57: No. 2, 189-192(23 Jun 1975).

The $\bar{p}p$ total cross section was measured from 2130 to 2250 MeV with mass resolution 2.25 MeV (FW). No fine structure was found with $\sigma\Gamma$ above the statistical limit of 7 MeV mb. A spin J particle coupled to the $\bar{p}p$ system must have partial width less than 1.8/(2J + 1) MeV. (auth)

**29371** PROBABLE EXAMPLE OF A NONMESONIC DOUBLE HYPERNUCLEUS. Mondal, A. S.; Basak, A. K.; Kasim, M. M.; Husain, A. (Rajshahi Univ., India). Nuovo Cim., A; 28A: No. 1, 42-50(1 Jul 1975).

A search is made to identify hypernuclear species with two or more decay centers in nuclear emulsion exposed to a separated beam of 3.0 GeV/c $K^-$-mesons at the CERN Proton Synchrotron. In a sample of 493 hypernuclei one event has been observed whose most probable interpretation turns out to be $^{31}Si_{\Lambda\Lambda}$ with the successive decay modes $^{31}Si_{\Lambda\Lambda} \rightarrow {}^{14}C_{\Lambda} + {}^{16}O + n \rightarrow {}^{4}He + {}^{3}H + {}^{3}H + {}^{2}H + {}^{2}H + n$, and binding energy $B_{\Lambda\Lambda} = (38.2 \pm 6.3)$ MeV. (6 tables) (auth)

**29372** SEARCH FOR MAGNETIC MONOPOLES AT THE CERN-ISR WITH PLASTIC DETECTORS. Giacomelli, G. (Univ., Bologna); Rossi, A. M.; Vannini, G.; Bussiere, A.; Baroni, G.;

Di Liberto, S.; Petrera, S.; Romano, G. Nuovo Cim., A; 28A: No. 1, 21-28(1 Jul 1975).

A search for Dirac's magnetic monopoles produced in pp collisions was performed at the CERN-ISR employing plastic detectors. The search was sensitive to poles with a mass $m_g \lesssim 30$ GeV. For $m_g < 20$ GeV and a magnetic charge $0.4g_0 < g < 2.5g_0$ the search yielded an upper limit on the production cross-section of $\sigma < 2 \cdot 10^{-36}$ cm$^2$ (95% confidence level). (2 tables, 3 figures) (auth)

**29373** POLARIZATION MEASUREMENTS IN $\pi^-$p, K$^-$p AND ANTI pp ELASTIC SCATTERING AT 40 GeV/c. Gaidot, A.; Bruneton, C.; Bystricky, J.; Cozzika, G.; Deregel, J.; Ducross, Y.; Khantine-Langlois, F.; Lehar, F.; de Lesquen, A.; Merlo, J. P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Phys. Lett., B; 57: No. 4, 389-392(21 Jul 1975).

Final results are reported on the polarization parameter P in elastic scattering of $\pi^-$, K$^-$ and antiprotons at 40 GeV/c incident momentum. The energy dependence of P(t) in $\pi^-$p above 10 GeV/c is well fitted by $P(t) \propto s^{\alpha_R(t)-\alpha_P(t)}$ where $\alpha_R(t)$ are the effective Regge and Pomeron trajectories respectively. The data in K$^-$p are compatible with exchange degeneracy. The results in $\bar{p}$p show an important structure for $|t| > 0.3$ (GeV/c)$^2$ demonstrating the existence of a large helicity flip amplitude. (auth)

**29374** MEASUREMENT OF THE REAL PART OF THE FORWARD AMPLITUDE IN ANTI p p ELASTIC SCATTERING. Jenni, P.; Baillon, P.; Bricman, C.; Ferro-Luzzi, M.; Perreau, J. M.; Tripp, R. D.; Ypsilantis, T. (European Organization for Nuclear Research, Geneva (Switzerland)); Declais, Y.; Seguinot, J. (Caen Univ., 14 (France)). Nucl. Phys., B; 94: No. 1, 1-20(4 Aug 1975).

The differential cross sections of the elastic $\bar{p}$p reaction were measured at 1.2, 1.4, 1.8 and 2.6 GeV/c incident $\bar{p}$ momentum. The measurements were performed at the CERN PS using a system of multiwire proportional chambers. The angular region covers scattering angles from 0 to ~200 mrad. Interference effects between the Coulomb and the nuclear amplitudes are used to derive the ratio of the real to imaginary part of the forward nuclear amplitude. These ratios are compared with theoretical predictions. (auth)

**29375** OBSERVATION OF A HIGH-MASS DELTA$^{++}$ PRODUCED IN ASSOCIATION WITH K*, rho AND omega. Chung, S. U.; Protopopescu, S. D. (Brookhaven National Lab., Upton, N. Y. (USA)); Eisner, R. L. (Case Western Reserve Univ., Cleveland, Ohio (USA)); Alston-Garnjost, M.; Barbaro-Galtieri, A.; Friedman, J. H.; Lynch, G. R.; Rabin, M. S.; Solmitz, F. T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Flatte, S. M. (California Univ., Santa Cruz (USA)). Phys. Lett., B; 57: No. 4, 384-388(21 Jul 1975).

Strong evidence is presented for quasi-two-body production of a pi$^+$p enhancement with mass 1881 ± 6 MeV and width 219 ± 23 MeV, recoiling off vector mesons rho$^0$ and omega from pi$^+$p interactions at 7.1 GeV/c and K*$^0$(890) from K$^+$p interactions at 12 GeV/c. The most probable J/sup P/ assignment for this object is 7/2$^+$, making it a likely candidate for the Regge recurrence of DELTA(1236). (auth)

## *Strong (Meson-induced)*

**29376** (INIS-mf-1739, pp 92-105) CHARACTERISTICS OF EIGHT-PRONG K$^+$p INTERACTIONS AT 8.2 GeV/c. Coghen, T.; Zalevska, A. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4-10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

A sample of about five hundred eight-prong events from the Brussels-CERN experiment is investigated. The single particle distributions and the Goldhaber-Goldhaber-Lee-Pais-type correlations for K$\pi$ and $\pi\pi$ pairs are studied. (auth)

**29377** (INIS-mf-1739, pp 122-130) THE PRODUCTION OF K*$^0$ $\Delta^0$ AND K*$^-$ $\Delta^+$ IN K$^-$p REACTIONS AT 4.2 GeV/c. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

Amsterdam-CERN-Nijmegen collaboration.

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, Jun 4-10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

The purity of simultaneous production of K* and $\Delta$ was studied in the four-body final states K$^-$p → (K$^-$ $\pi^+$) ($\pi^-$p) K$^-$p - (K$^0\pi^-$) ($\pi^0$ p) and K$^-$p → (K$^0\pi^-$) ($\pi^+$n) in a high statistics experiment at 4.2 GeV/c. For the first two reactions the decay distributions of the K* and in particular the $\Delta$ are far from symmetric. Evidence is presented that most of this asymmetry comes from overlap and possibly interference with diffraction dissociation. (auth)

**29378** (INIS-mf-1739, pp 131-139) INTERFERENCE BETWEEN $\Delta^{++}$ AND Q$^-$ PRODUCTION IN K$^-$p → K$^-\pi^-\pi^+$p AT 4.2 GeV/c. MacNaughton, J. N.; Heinen, P. M.; Kittel, W.; Metzger, W. J.; Tiecke, H.G.J.; Van de Walle, R. T. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4-10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

Evidence is found for interference between $\Delta^{++}$ and Q$^-$ production in K$^-$p → K$^-\pi^-\pi^+$p at 4.2 GeV/c. The interference phase is such that the extrapolated $\pi^+$p ($Y_1^1$) moment in the Jackson frame disagrees with real $\pi^+$p scattering in the region of the $\Delta^{++}$. The Q causes disagreement over a wide $\pi^+$p mass range between the $\pi^+$p moments observed in the s-channel helicity frame and those expected on the basis of real $\pi^+$p scattering. The discrepancy remains even after extrapolation to the pion pole. (auth)

**29379** (INIS-mf-1739, pp 490-492) ON THE STUDY OF INELASTIC 40 GeV/c PION INTERACTION WITH C AND Cu NUCLEI. Nikanorov, V. I. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4-10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

Some preliminary results of the experiment on the study of the spectra of positively charged particles emitted at 0$^0$ due to 40 GeV/c negative pion interactions with C and Cu nuclei are given. (auth)

**29380** (JINR-1-7884) SOME RESEARCH PROBLEMS OF STRANGE PARTICLE PRODUCTION IN $\pi^-$p-INTERACTIONS AT 5 GeV/c IN THE JINR 100 cm LIQUID HYDROGEN BUBBLE CHAMBER. Popova, V. M.; Glagolev, V. V.; Kladnitskaya, E. N.; Kuznetsov, A. A.; Lebedev, R. M.; Pestova, G. D.; Sabehu, M.; Saitov, I. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 11p. (In Russian). INIS.

9 refs.; 5 figs.; 1 table.

Questions on the method for extracting reaction cascades in the $\pi^-$p interaction with formation of strange particles at 5 GeV/sec were studied from photographs of the 100-cm hydrogen chamber at JINR. (tr-auth)

**29381** (JINR-R-1-7680) $\pi$-N COLLISIONS OF HIGH MULTIPLICITY $n^{\pm 5}$ AT P = 40 GeV/c. Abdurakhimov, A. U.; Angelov, N.; Grishin, V. G.; Ivanovskaya, I. A.; Kanarek, T.; Kladnitskaya, E. N.; Lyubimov, V. B.; Mel'nikova, N. N.; Solov'ev, M. I.; Fadeev, N. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 41p. (In Russian). INIS.

16 refs.; 15 figs.; 20 tables; submitted to Soviet Journal of Nuclear Physics.

The momentum and angular distributions of secondary charged $\pi$ mesons, the coefficients of inelasticity, and the cross-sectional and longitudinal momentum distribution of $\pi^+$ mesons formed in the $\pi^-$N → N + n$\pi^\pm$ (n ± = 5, 6, ..., 12) for P = 40 GeV/c are given. Experimental results are compared with those predicted from statistical theory. (tr-auth)

**29382** (JINR-R-1-8147) CROSS SECTIONS OF STRANGE PARTICLE PRODUCTION IN THE $\pi^-$p INTERACTIONS AT 5 GeV/c. Dushutin, N. K.; Popova, V. M.; Glagolev, V. V.;

Kladnitskaya, E. N.; Kuznetsov, A. A.; Lebedev, R. M.; Mal'tsev, V. M.; Pestova, G. D.; Sabehu, M.; Saitov, I. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 15p. (In Russian). INIS.

10 refs.; 5 tables; 6 figs.

Results of determination of the cross sections of reaction of production of strange particles with 5-GeV/c momenta are compiled and compared with data at other energies. They are used for analyzing the mechanism of production of strange particles by verifying the principle of sums for the cross sections. (tr-auth)

**29383** (JINR-R-1-8187) MULTIPLICITY OF SECONDARY PARTICLES PRODUCED IN $\pi^-$p- INTERACTIONS AT 40 GeV/c. Angelov, N.; Grishin, V. G.; Kerachev, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 10p. (In Russian). INIS.

9 refs.; 2 figs.; 2 tables.

Dispersions were determined for the multiplicity of $\pi^0$ mesons and all secondary particles formed in $\pi^-$p interactions with 40-GeV/c momenta. The data obtained were compared with a phenomenological model. (tr-auth)

**29384** (LBL-4224) DECAY INTO STRANGE BARYON-ANTIBARYON PAIRS AND AN I-SPIN DETERMINATION OF THE PSI(3095). Goldhaber, G.; Johnson, A. D.; Kadyk, J. A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 15 Aug 1975. Contract W-7405-ENG-48. 17p. (SLAC-PUB-1622; CONF-750547-13). Dep. NTIS $4.00.

From 4th international symposium on nucleon-antinucleon interactions; Syracuse, New York, USA (2 May 1975).

Data are given for PSI(3095) decay into LAMBDA anti LAMBDA, and some evidence is shown for the channels SIGMA anti SIGMA and possibly XI anti XI. The final states SIGMA anti SIGMA and XI anti XI are ambiguous with LAMBDA anti LAMBDAX$^0$, for example, LAMBDA anti LAMBDApi$^0$. The decay PSI(3095) yields LAMBDA anti LAMBDA is of particular interest because the LAMBDA anti LAMBDA pair is in a pure I equals 0 state. It is shown that this decay proceeds directly rather than through an intermediate gamma, and thus one obtains a determination of the isospin of the PSI(3095). (JFP)

**29385** (RL-75-115) NEW RESULTS ON STRANGENESS ± 1 BARYONS. Ross, R. T. (Science Research Council, Chilton (UK). Rutherford Lab.). Jul 1975. 23p. (CONF-750654-17). Dep. NTIS (US Sales Only) $4.25.

From high energy particle physics divisional conference of EPS; Palermo, Italy (23 Jun 1975).

The low energy $K^-p$ data situation is summarized. Two new $S = -1$ two-body phase shift analyses are discussed. These cover the c.m. energy regions 1480 to 2170 MeV and 2060 to 2400 MeV. New data from $K^-_1 p \to K^-_2 p$, $\Lambda\pi^+$, $\Sigma^0\pi^+$ from two experiments are compared, and the conclusions concerning $Z_0$ amplitudes are discussed. (auth)

**29386** ANALYSIS OF THE REACTION $\pi^-p \to p\pi^+\pi^-\pi^-\pi^0$ AT THE MOMENTUM OF 4.5 GeV/c BY MEANS OF THE REGGE POLE EXCHANGE MODEL. Beketov, G. V.; Garanina, T. A.; Grechko, V. E.; Dement'ev, R. K.; Zombkovskii, S. M.; Kaidalov, A. B.; Konovalov, B. S.; Kruchinin, S. P.; Pozhidaeva, N. A.; Selektor, Ya. M.; Turov, V. F.; Shulyachenko, V. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 21: No. 4, 811-824(Apr 1975). (In Russian).

The reaction $\pi^-p \to p\pi^+\pi^-\pi^-\pi^0$ was investigated at the momentum of 4.5 GeV/c by means of the liquid hydrogen bubble chambers with sizes 50 and 55 cm. The obtained data are compared with predictions of the Regge-pole exchange model. It is shown that the model provides with reasonable predictions on absolute cross sections and main characteristics of the reaction: distributions in effective masses of two, three and four secondary particles, distributions in various 4-momentum transfers, as well as angular distributions of secondary particles in the c. m. frame of the reaction. (8 figures) (auth)

**29387** CHARGE ASYMMETRY IN INELASTIC pi-p INTERACTIONS AT 205 GeV/c FOR PARTICLES WITH TRANSVERSE MOMENTUM GREATER THAN 1.0 GeV/c. Fretter, W. B.; Graves, W. R.; Bingham, H. H.; Chew, D. M.; Daugeras, B. Y.; Johnson, A. D.; Kadyk, J. A.; Stutte, L.; Trilling, G. H.; Winkelmann, F. C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Phys. Lett., B; 57: No. 2, 197-200(23 Jun 1975).

In 205 GeV/c pi$^-$p inelastic interactions, negative particles with transverse momentum greater than 1.0 GeV/c moving forward in the center of mass outnumber similar positive particles by a factor of 3.7 to 1, greatly in excess of the corresponding ratio for small transverse momentum. The asymmetry is reversed in the backward direction. The forward asymmetry is most prominent in 2-, 4-, and 6-prong interactions, but both forward and backward asymmetries are also substantial for higher multiplicity interactions. (auth)

**29388** K$^-$p ELASTIC SCATTERING BETWEEN 1094 MeV/c AND 1377 MeV/c. Barber, P. C.; Broome, T. A.; Duff, B. G.; Heymann, F. F.; Imrie, D. C.; Lush, G. J.; Mgbenu, E. N.; Potter, K. M.; Robbins, L. A.; Rosner, R. A. (University Coll., London (UK)). Nucl. Phys., B; 92: No. 3, 391-403(7 Jul 1975).

Differential cross sections for elastic scattering of negative kaons on protons are presented for 13 incident laboratory momenta between 1094 MeV/c and 1377 MeV/c. The data show the characteristic forward diffraction-like peak and backward dip and are adequately described in shape by certain published partial-wave analyses of the $\bar{K}N$ system. (auth)

**29389** INCLUSIVE ANTILAMBDA PRODUCTION IN K-p INTERACTIONS AT 14.3 GeV/c. Bardadin-Otwinowska, M. (CEN de Saclay, Gif-sur-Yvette, France); Barloutaud, R.; Borg, A.; Louedec, C.; Spiro, S.; Chaurand, B.; Gago, J.; Labrosse, G.; Lestienne, R.; Paler, K.; Tovey, S.; Shah, T. P. Lett. Nuovo Cim.; 13: No. 16, 597-600(16 Aug 1975).

The $K^-p \to$ anti $\Lambda$ + anything reaction has been studied for a $K^-$ beam of 14.3 GeV/c. Inclusive anti $\Lambda$ cross sections are tabulated for various charged multiplicities and polarization is found to be zero. Main production occurs in association with $\Lambda$, $\Sigma^+\Sigma^-$, or $\Sigma^*$ and production of the anti $\Lambda \equiv$ system, which could result from the fragmentation of the incident $K^-$, is believed to be significant. (1 table, 4 figures) (SDF)

**29390** MEASUREMENT AND PHASE-SHIFT ANALYSIS OF THE P PARAMETER IN $\pi^+$p SCATTERING AT 236 MeV. Amsler, C.; Rudolf, F.; Weymuth, P. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)); Dubal, L.; Eaton, G. H.; Frosch, R.; Mango, S.; Pozar, F. (Schweizerisches Inst. fuer Nuklearforschung, Villigen). Phys. Lett., B; 57: No. 3, 289-292(7 Jul 1975).

The P parameter for $\pi^+$p scattering at 236.3 MeV has been measured between 50° and 146° c.m. with very low background using a butanol polarized proton target. The resulting D phases are in fair agreement with dispersion relation values. (auth)

**29391** SEARCH FOR EXOTICS PRODUCED OPPOSITE A FORWARD $\Lambda$ IN 15 GeV/c $\pi^+$p INTERACTIONS. Baltay, C.; Cautis, C. V.; Cohen, D.; Kalelkar, M.; Pisello, D. (Columbia Univ., New York (USA)); Smith, W. D.; Yeh, N. (State University of New York at Binghamton, USA). Phys. Lett., B; 57: No. 3, 293-296(7 Jul 1975).

A search has been made for exotic meson resonances produced in the reaction $\pi^+p \to K^{++} + \Lambda$(forward) at 15 GeV/c. No evidence has been found for the existence of resonance-like states in the $K^{++}$ system, and 95% confidence level upper limits of 1.7 $\mu$b were found on their production with masses < 2.8 GeV, and 2.6 $\mu$b with masses between 2.8 GeV and 4 GeV. (auth)

**29392** INCLUSIVE STRANGE PARTICLE PRODUCTION IN $\pi^+$p INTERACTIONS AT 16 GeV/c. Bosetti, P.; Deutschmann, M.; Graessler, H.; Otter, G.; Seyfert, H. H. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.); Boeckmann, K.; Hofmann, J.; Lowsky, J.; Zobernig, G. (Bonn Univ. (F. R. Germany). Physikalisches Inst.); Cocconi, V. T. Nucl. Phys., B; 94: No. 1, 21-38(4 Aug 1975).

The production of $K^0_S$, $\Lambda$ and $\bar{\Lambda}$ is measured in $\pi^+$p reactions at 16 GeV/c. The total strange particle cross section is found to be 4.0 ± 0.3 mb, about 20% of the inelastic cross section. Cross sections for single strange particles and for strange particle pairs are determined, both inclusively and as functions of the charged multiplicity. Relative production rates for different strange particle combinations are compared with the prediction of the isospin statistical model. Inclusive spectra for single particles are studied, and it is found the $K^0_S$ are produced mostly in the forward hemisphere, most probably by fragmentation of the incident pion into $K\bar{K}\pi$. The $\Lambda$ are mostly backwards, probably deriving from fragmentation of the proton into $\Lambda K$ pairs. The $\bar{\Lambda}$ tend to be produced forwards, but evidence is found for central $\Lambda\bar{\Lambda}$ production. Distributions in rapidity of the $\Lambda$ particles from $\pi^+$p interactions are compared in terms of the factorization hypothesis. Results are given on the $\Lambda$ transversal polarization. (auth)

**29393** MEASUREMENT OF THE SPIN ROTATION PARAMETER R IN $\pi^-$p AND K$^-$p ELASTIC SCATTERING AT 40 GeV/c. Pierrard, J.; Bruneton, C.; Bystricky, J.; Cozzika, G.; Deregel, J.; Ducros, Y.; Gaidot, A.; Khantine-Langlois, F.; Lehar, F.; Lesquen, A. de (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Phys. Lett., B; 57: No. 4, 393-397(21 Jul 1975).

The spin rotation parameter R was measured for elastic $\pi^-$p scattering at 40 GeV/c, at four momentum transfers t ranging from $-0.19$ to $-0.52$ (GeV/c)$^2$. The average value within this

interval is $R_{\pi^-p} = -0.200 \pm 0.023$. The resulting constraints on the πN scattering amplitudes are discussed. The experiment also yields an average value for $K^-p$ scattering, $R_{K^-p}$ scattering, $R_{K^-p} = -0.16 \pm 0.16$. (auth)

**29394** OBSERVATION OF A SPIN 4 NEUTRAL MESON WITH 2 GeV MASS DECAYING IN $\pi^0\pi^0$. Apel, W. D.; Augenstein, K.; Kruger, M.; Mueller, H.; Schneider, H. (Karlsruhe Univ. (TH) (F. R. Germany). Inst. fuer Experimentelle Kernphysik); Bertolucci, E.; Mannelli, I.; Pierazzini, G. M.; Quaglia, M.; Scribano, A. Phys. Lett., B; 57: No. 4, 398-402(21 Jul 1975).

The invariant mass spectrum of neutral meson states from $\pi^-p$ interactions at 40 GeV/c incident momentum was investigated in a high statistics experiment performed at the 70-GeV IHEP accelerator. To detect the high energy photons coming from the produced neutral states, a hodoscope spectrometer with a computer on-line was used. A clear structure on the mass spectrum of dipions produced in the reaction $\pi^-p \to \pi^0\pi^0n$ is observed at 2 GeV. The decay angular distributions show in this mass region the variation with mass typical of a state with a spin J = 4. The mass of the observed meson is found to be M = (2020 ± 30) MeV and the estimate of the full width is (180 ± 60) MeV. (auth)

**29395** OBSERVATION OF A SPIN 4 BOSON RESONANCE AT 2050 MeV. Blum, W.; Dietl, H.; Grayer, G.; Hentschel, G.; Lorenz, E.; Luetjens, G.; Lutz, G.; Maenner, W.; Meissburger, J.; Richter, R. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (F. R. Germany)). Phys. Lett., B; 57: No. 4, 403-406 (21 Jul 1975).

The observation of a spin-4 resonance is reported from the analysis of the reaction $\pi^-p \to K^+K^-n$. The mass and width of the h-meson were determined to be 2050 MeV and 225 MeV. The quantum numbers are $J^P = 4^+$, C = +1 and very probably $I^G = 0^+$. (auth)

**29396** OBSERVATION OF THE TWO PHOTON CASCADE $3.7 \to 3.1 + \gamma\gamma$ VIA AN INTERMEDIATE STATE $P_c$. Braunschweig, W.; Martyn, H.-U.; Sander, H. G.; Schmitz, D.; Sturm, W.; Wallraff, W. (Technische Hochschule Aachen (F. R. Germany). 1. Physikalisches Inst.); Berkelman, K.; Cords, D.; Felst, R.; Gadermann, E. Phys. Lett., B; 57: No. 4, 417-412 (21 Jul 1975).

The two photon cascade decay of the 3.7-GeV resonance into the 3.1-GeV resonance was observed in two nearly independent experiments. The clustering of the photon energies around 160 and 420 MeV observed in the channel $3.7 \to (3.1 \to \mu^+\mu^-) + \gamma\gamma$ indicates the existence of at least one intermediate state with even charge conjugation at a mass around 3.52 or 3.26 GeV. (auth)

**29397** THE REACTION $\pi^-p \to \eta n$ UP TO $p_\eta^* = 450$ MeV/c: EXPERIMENTAL RESULTS AND PARTIAL-WAVE ANALYSIS. Feltesse, J.; Ayed, R.; Bareyre, P.; Borgeaud, P.; David, M.; Ernwein, J.; Lemoigne, Y.; Villet, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France). Dept. de Physique des Particules Elementaires). Nucl. Phys., B; 93: No. 2, 242-260(21 Jun 1975).

An accurate measurement of $d\sigma^o/d\Omega$ ($\pi^-p \to \eta n$) at 1531 MeV total energy (expanded up to l = 4 Legendre polynomials) requires reconsideration of previous angular distribution fits which were expanded only up to l = 2 and of subsequent partial-wave analysis. An energy-dependent partial-wave analysis was performed here for $p_\eta^*$ up to 450 MeV/c. In addition to the well known $S_{11}$ (1520 MeV) resonance, either the $P_{11}$ (1532 MeV) or the $P_{13}$ (1530 MeV) resonance is found to be strongly coupled to the η-n channel. In both cases, the $P_{11}$ (1729 MeV) resonance is needed as is the weakly coupled $D_{13}$ (1525 MeV) resonance. The decay states in the ηn channel are compared to the SU(3) and $SU(6)_W$ predictions. (auth)

**29398** EVIDENCE FOR DIFFERENT POLARISATION PROPERTIES OF THE ρK AND K*(890)π STATES OF THE $1^+$ WAVE IN THE Q REGION. Otter, G.; Rudolph, G.; Rumpf, K.; Wieczorek, H. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.); Boettcher, H.; Nowak, W. D. (Akademie der Wissenschaften der DDR, Berlin-Zeuthen. Inst. fuer Hochenergiephysik); Cocconi, V. T.; Counihan, M. J.; Hansen, J. D.; Jones, G. T. Nucl. Phys., B; 93: No. 3, 365-386(28 Jul 1975).

A partial-wave analysis was performed on the $(K^-\pi^-\pi^+)$ system produced in the reaction $K^-p \to K^-\pi^-\pi^+p$ at 10 and 16 GeV/c. In the Q mass region it is found that the two dominant states, K*π and Kρ, both in $1^+S$ wave, are produced with different polarizations, helicity being approximately conserved in the t-channel for K*π and in the s-channel for Kρ. This is in contradiction with the assumption that the amplitude can be factorized into "production" and "decay" parts, and hence that the two amplitudes are fully coherent. The phase variation of the two states does not indicate simple resonance behavior. It is concluded that the Q-mass enhancement is composite. (auth)

**29399** $K^-p$ CROSS SECTIONS BETWEEN 1.1 AND 1.4 GeV/c. Givselin, J.; Griernaud, A.; Barloutaud, R.; Prevost, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France). Dept. de Physique des Particules Elementaires); Gandini, F.; Kiesling, C.; Plane, D. E.; Wittek, W. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (F. R. Germany)); Baillon, P.; Bricman, C. Nucl. Phys., B; 93: No. 2, 189-216 (21 Jun 1975).

$K^-p$ reactions were studied at 13 different momenta between 1138 and 1434 MeV/c. This interval corresponds to a mass of the $K^-p$ system varying from 1858 to 1993 MeV. About 300,000 photographs were taken in the 81-cm Saclay hydrogen bubble chamber exposed to a separated $K^-$ beam at the CERN proton-synchrotron. A total of about 44,000 events were analyzed, from which partial and differential cross sections were determined. Polarizations were obtained for the two-body reactions where the decay of the Λ or Σ hyperon allowed their measurement. Data for the two-body channels are presented here as well as for the main quasi-two-body reactions. (auth)

**29400** MEASUREMENT OF THE REACTIONS $K^+d \to K^+d$ and $K^+d \to K^+pn$ AND AN INVESTIGATION OF ELASTIC $K^+$-NUCLEON SCATTERING AT 4.6 GeV/c. Dehm, G.; Geist, W.; Goebel, G.; Wittek, W.; Wolf, G. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (F. R. Germany)). Nucl. Phys., B; 93: No. 3, 387-404(28 Jul 1975).

The coherent elastic reaction $K^+d \to K^+d$ and the break-up reaction $K^+d \to K^+pn$ are studied in a $K^+d$ experiment at 4.6 GeV/c with the CERN 2 m bubble chamber. Partial and differential cross sections are given and the slopes of the differential cross sections are determined. The results for the reaction $K^+d \to K^+p(n_s)$, where $n_s$ denotes the spectator neutron, are compared with those of the reaction $K^+p \to K^+p$ on free protons. Combining these data with existing data on the reactions $K^+d \to K^0pp$ and $K^+p \to K^+p$, parameters of the elastic $K^+$ nucleon scattering at 4.6 GeV/c are determined in the framework of the Glauber model. The D-wave of the deuteron and spin-flip effects are taken into account. (auth)

# Particle Interactions and Properties (Theoretical)

## General

*Refer also to abstracts 29566, 29985, 30037, 30109, and 30115.*

**29401** (CONF-730750-) EIGHTH ANNUAL SEMINAR ON THEORETICAL PHYSICS, PRETORIA, SOUTH AFRICA, 9–13 JULY 1973. (South Africa Univ., Pretoria). Nov 1973. 269p. (In several languages).

The conference contained 14 papers. Separate abstracts were prepared for 13 papers. Other papers were outside the scope of NSA. (JFP)

*For abstracts of individual papers see: 27764, 27849, 29205, 29338, 29402, 29450, 29644–29647, 29896, 30085, and 30086.*

**29402** (CONF-730750-, pp E1-E53) INCLUSIVE REACTIONS. Butterworth, D. S. (University Coll., London). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

The hypotheses considered for the inclusive reactions include the Yang hypothesis of limiting fragmentation, Feynman scaling, Mueller theory, the Feynman gas, the multiperipheral, diffractive fragmentation, the field theoretic Cheng–Wu, the Hagedorn thermodynamic, and dual resonance models. Recent developments are also discussed. (JFP)

**29403** (FERMILAB-Lec-75/1-THY/EXP) INTRODUCTION TO $SU_4$ AND THE PROPERTIES OF CHARMED HADRONS. Einhorn, M. B. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Feb 1975. 52p. Dep. NTIS $5.75.

A series of lectures is given on the theoretical excitement surrounding the idea of a fourth charmed quark and to provide the foundation necessary to comprehend the rapidly growing literature on this subject. (JFP)

**29404** (IC-73-163) A LOCAL SPECTRAL FUNCTION OF THE MATRIX ELEMENT $\langle 0 | A_\mu^{1+i2}(x), A_\nu^{1-i2}(0) \rho^0(p,\lambda) \rangle$. Fakirov, D. G. (International Centre for Theoretical Physics, Trieste (Italy)). Oct 1973. 12p. INIS.

A local expression is found in explicit form for the spectral function of the matrix element of the current commutator $[A_\mu^{1+i2}(x), A_\nu^{1-i2}(0)]$ between vacuum and the $\rho^0$-meson state which is characterized by four-momentum p and polarization λ, or by

the four-vector of polarization $\epsilon$. The quantities $A^{\pm\pm i2}_{\mu,\nu}(x)$ by definition are combinations of the first two unitary components of the octet of axial current densities with "lowering" and "decreasing" operator properties in isospin space. The above-mentioned local expression in this approach results as a consequence of definite conditions imposed, on one hand, on the set of intermediate states which are used in the saturation procedure of the considered commutator and, on the other, on the behavior of the form factors considered as functions of the transferred four-momentum. (auth)

**29405** (INIS-mf-1739, pp 210-346) CORRELATIONS IN MULTIPARTICLE PRODUCTION. Ranft, J. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

166 refs.

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4–10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

A summary is given limited to differential correlations in rapidity, azimuthal angle and other variables in inclusive, semi-inclusive and exclusive reations. Experimental data on these correlations were discussed and compared to models of current interest as the cluster model and the Mueller Regge model. (auth)

**29406** (INIS-mf-1739, pp 557-598) WHAT IS HAPPENING AT LARGE TRANSVERSE MOMENTUM. Ellis, S. D. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

44 refs.

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4–10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

A review is given of the various theoretical models which were proposed as explanations of the observed large $p_\perp$ events. The models are compared in the context of present data. Suggestions are made as to which new measurements may prove useful to discriminate between the models. (auth)

**29407** (INIS-mf-1739, pp 608-642) MODELS FOR HIGH ENERGY PROCESSES. A Progress Report. Bassetto, A. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

49 refs.

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4–10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

The clustering phenomenon is examined as it is treated in different models. In particular the concepts of cluster formation and cluster decay are discussed, with a look at a dual picture. Two and many component models are reviewed as useful tools for describing the actual experimental situation and as a bridge towards models which aim for asymptotic self-consistency. Finally the problem of factorization is discussed in the light of a general multiperipheral dynamics. (auth)

**29408** (INIS-mf-1739, pp 643-671) FIREBALL DECAY IN THE STATISTICAL BOOTSTRAP MODEL (SBM). Kripfganz, J. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, Jun 4–10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

Some recent developments of the SBM are discussed. They are mainly directed to the calculation of the fireball decay spectra. The multiplicity distribution and the exclusive and inclusive momentum distribution of the stable particles arising from the decay are investigated in detail. The solution of the bootstrap equation is given. The influence of exotic decay channels is estimated. Some open problems and the relation to other models are discussed. (auth)

**29409** (JINR-P2-8975) RADIATIVE CORRECTIONS TO THE $\pi e$ SCATTERING. Bardin, D. Yu.; Shumeiko, N. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The radiative corrections to the elastic $\pi e$-scattering are calculated in a $\rho$-dominance model. It is shown that the corrections thus calculated practically equal those for the "pointlike" pion, up to energies of the initial pion $E_\pi = 400$ GeV. (auth)

**29410** (JINR-R-2-8055) INTERACTIONS DEPENDING ON RATE IN MULTIPLE PRODUCTION. Mal'tsev, V. M.; Dushutin, N. K.; Sinegovskii, S. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 10p. (In Russian). INIS.

6 refs.; 1 table.

The possibility of interaction as a function of rate in multiple formation of particles is considered, and the physical interpretation of these interactions is discussed and compared with experimental data. (tr-auth)

**29411** (JINR-R-2-8069) PARTICLE CORRELATIONS WITH SMALL RELATIVE MOMENTA. Kopylov, G. I.; Lyuboshits, V. L.; Podgoretskij, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 17p. (In Russian). INIS.

5 refs.

For a pair of particles whose pulses are close, the "dying off" of the state with odd relative orbital moments enters in with $|\vec{P}_1 - \vec{P}_2|\ R < \hbar/R$, where R is the dimension of the field of particle generation. The dependence of the coefficient of asymmetry in the angular dispersion of the vector $\vec{P}_1 - \vec{P}_2$ (where $\vec{P}_1 + \vec{P}_2 = 0$) on $|\vec{P}_1 - \vec{P}_2|$ makes it possible to evaluate R. (tr-auth)

**29412** (RL-75-080) SOME CONSEQUENCES OF AN ATTEMPT TO IDENTIFY CLUSTERS WITH RESONANCES. Gula, A. (Science Research Council, Chilton (UK). Rutherford Lab.). May 1975. 33p. Dep. NTIS (US Sales Only) $4.75.

The dual, unitary model of Chan, Paton and Tsou is interpreted in terms of clusters which, according to the model, are semi-locally averaged resonances rather than new physical objects. Predictions concerning the semi-inclusive rapidity and azimuthal correlations and the variation of transverse momentum with multiplicity and energy are discussed. With no free parameters for the cluster production the standard assumptions about cluster decay, a remarkable agreement with experimental data is obtained. (9 figures) (auth)

**29413** EXACT SOLUTION OF THE N/D-METHOD EQUATIONS FOR THE RESONANCE-PARTICLE INTERACTION AMPLITUDE. Badalyan, A. M.; Simonov, Yu. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 21: No. 4, 890-901(Apr 1975). (In Russian).

Unitarity relations for the amplitude of interaction of a particle with a two-particle resonance is deduced from the unitarity relations for the interaction amplitude for three identical spinless particles. The obtained equations allow an exact solution in terms of the N/D method, which is explicitly written. Analytical properties of the solution are studied and it is shown that the denominator has no Peierls singularity and does not vanish near the physical region. Discussion is presented of some incorrect results, known in the literature and contradicting our results. (11 figures) (auth)

**29414** MULTIPLE PRODUCTION OF HADRONS AND PREDICTIONS OF THE LANDAU THEORY. Zhirov, O. V.; Shuryak, E. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 21: No. 4, 861-867(Apr 1975). (In Russian).

A number of physical effects, account of which is important in obtaining quantitative predictions of the hydrodynamical theory, are discussed. Corrections to the state equations due to the strong interactions are considered. The role of the leading particles inducing substantial fluctuations in the system is discussed. The multiplicity distribution and the inclusive spectra calculated with account of these factors agree with the experimental data. (3 figures, 1 table). (auth)

**29415** IDEAL RELATIVISTIC QUANTUM GAS AND INVARIANT PHASE SPACE. Chaichian, M.; Hagedorn, R. (European Organization for Nuclear Research, Geneva (Switzerland)); Hayashi, M. (Saitama College, Moroyama, Saitama, Japan). Nucl. Phys., B; 92: No. 3, 445-468(7 Jul 1975).

The density of states of an ideal relativistic gas with Bose-Einstein or Fermi-Dirac statistics is written in closed form

as a cluster decomposition over the usual phase-space integrals with Boltzmann statistics. The difference between invariant phase space and invariant momentum space is stressed; only the former gives the correct description of ideal gases. The results are formulated for the microcanonical, grand microcanonical, canonical and grand canonical ensembles in invariant phase space and invariant momentum space. A whole section is devoted to a numerical study, which reveals that while under normal conditions thermodynamical quantities (derived from the logarithm of the density of states) acquire only very small corrections, the densities (phase-space integrals) themselves are significantly changed. This holds in particular for elementary particle applications (statistical models, phase-space considerations) where the effects on phase space of Bose-Einstein and/or Fermi-Dirac statistics can almost never be neglected; however, in these applications, the number of equal particles is so low that the cluster decompositions can be explicitly evaluated. (auth)

**29416** MULTIPLICITY BOOTSTRAP AND THE DUAL UNITARITY EQUATION. Dias de Deus, J. (Science Research Council, Chilton (UK). Rutherford Lab.). Nucl. Phys., B; 92: No. 3, 469-476(7 Jul 1975).

In some approximation, the dual unitarity equation is treated as a bootstrap equation for the pomeron amplitude and the n-particle production cross sections. The solution of the bootstrap requires $\alpha_P = 1$ for the pomeron intercept independent of the reggeon trajectory. Agreement with multiplicity data strongly constrains the reggeon intercept $\alpha_R$ to be very close to $\frac{1}{2}$. (auth)

**29417** HELICITY STRUCTURE OF THE TRIPLE-REGGE FORMULA. Sakai, N.; Uschersohn, J. (Science Research Council, Chilton (UK). Rutherford Lab.). Nucl. Phys., B; 92: No. 3, 507-523(7 Jul 1975).

The dependence of the triple-Regge vertex on three of its five variables is shown to be equivalent to the spin and helicity structure of the missing mass state X in the reaction $a + b \to c + X$. In particular, if the triple-Regge vertex depends only on the squared momentum transfers t, $t_1$, and $t_2$, the t-channel helicity in this reaction is conserved. (auth)

**29418** RAPIDITY GENERATOR FOR MONTE-CARLO CALCULATIONS OF CYLINDRICAL PHASE SPACE. Jadach, S. (Uniwersytet Jagiellonski, Krakow (Poland). Instytut Fizyki). Comput. Phys. Commun.; 9: No. 5, 297-304(May 1975).

Analysis of high energy collisions of hadrons in the framework of many theoretical models needs numerical evaluation of multidimensional integrals over Lorentz invariant phase space. In practice, the only method of evaluating them exactly is the Monte-Carlo method. However, if methods of random generation of points in the phase space known up to now are used, the time of evaluation of these integrals increases not only with the number of particles, but also very rapidly with energy and Monte-Carlo calculations of phase space integrals for laboratory momentum over a thousand GeV/c are practically impossible. A new method of solving this problem is presented. It is proposed to generate rapidity variable instead of longitudinal momenta, or some kind of intermediate masses. When this method is applied the calculation time for a fixed number of outgoing particles remains nearly constant when the energy increases. (auth)

**29419** DIAGONALIZATION OF THE DILATATION GENERATOR AND ANOMALOUS DIMENSIONS IN THE THIRRING MODEL. Girardello, L.; Montaldi, E. (Milan Univ. (Italy). Istituto di Scienze Fisiche). Phys. Lett., B; 57: No. 2, 155-158(23 Jun 1975).

A conjecture by Fubini, Hanson and Jackiw is proved in the framework of the Thirring model, where anomalous dimensions are explicitly exhibited as shifted poles in the dilatation propagator. (auth)

**29420** NUCLEON RESONANCES AND ANOMALOUS DIMENSIONS. Konishi, K. I. (Kyoto Univ. (Japan). Dept. of Physics). Phys. Lett., B; 57: No. 2, 169-172(23 Jun 1975).

It is studied whether duality analogous to that of Bloom and Gilman holds in the case in which the non-canonical scaling proves to be true. The data show that such duality holds well, independently of $Q^2$. (auth)

**29421** MODIFIED TWO-COMPONENT MODEL FOR PARTICLE PRODUCTION AND MULTIPLICITY DISTRIBUTION AT HIGH-ENERGY. Minami, S. (Osaka City Univ.). Lett. Nuovo Cim.; 13: No. 16, 615-619(16 Aug 1975).

A modified two-component model for particle production is suggested in which i) the effects of the increase of the inelastic cross section in a high-energy region are taken into account and ii) the average multiplicity not only for nondiffractive production but also for diffraction depends on energy. It is shown that experimental data for the multiplicity distributions in p-p and $K^+$-p collisions can be explained well by using the expression $\sigma_{2n+2}$ in our model, where $\sigma_{2n+2}$ is the (2n + 2)-prong cross-section in the reactions. (auth)

**29422** REAL PART OF A GEOMETRICAL POMERON. Dias de Deus, J. (Rutherford Lab., Chilton, Eng.). Nuovo Cim., A; 28A: No. 1, 114-125(1 Jul 1975).

It is shown that geometrical scaling for the pomeron implies the following fixed-s t-derivative analyticity relation: Re F(s, t)/Re F(s,0) = the partial time derivative of [t(Im F(s,t)/Im F(s,0))]. Applications of this relation are discussed. In particular we obtain that i) the slope parameter of Re F(s,t) at t = 0 is the double of the slope parameter of Im F(s,t), ii) Re F(s,t) must have a zero around t = 0.2, iii) the real part of the pomeron has a peripheral structure in the impact-parameter plane. (2 figures) (auth)

**29423** HYPOTHETICAL PARTICLES. Goldhaber, A. S.; Smith, J. (State Univ. of New York, Stony Brook). Rep. Prog. Phys.; 38: No. 6, 731-770(Jun 1975).

A review is given of the status of hypotheses about various undiscovered particles. Magnetic monopoles, intermediate bosons, heavy leptons, scalar particles, quarks, tachyons and gravitons are discussed, along with speculations about the newly discovered neutral mesons. (auth)

**29424** EXPERIMENT SHOWING RELATION OF 4-DIMENSIONAL SPACE TO ELEMENTARY PARTICLE STRUCTURE. Akulov, N. S. (Dept. of Physics of Nondestructive Testing, Minsk). Dokl. Akad. Nauk BSSR; 19: No. 5, 399-402(May 1975). (In Russian).

A conceptual experiment is described for showing the basic correlation of the relativity theory, i.e., an expression for 4-vector momentum energy which shows that the theory of relativity may be presented from the viewpoint that elementary particles are complex and have finite dimensions. For the electron radius the ratio obtained is the same as that of the Dirac theory. The classical analog of spin for elementary particles becomes evident, as the most recent studies of the de Broglie school require. Results obtained make it possible to eliminate the discrepancy of the variant of the relativity theory accepted by well known scientists and resulting from the Dirac theory and the principle of inexhaustibility and the principles of dielectrical materialism. Basic relations are shown between the quantum theory of relativity and the formula for the dependence of the electron radius and the rate of movement of the observer. The results show a linear unit theory of particles and fields. (tr-auth)

**29425** TWO-BODY HADRONIC DECAYS OF THE 3.1 GeV RESONANCE. Braunschweig, W.; Martyn, H. U.; Sander, H. G.; Schmitz, D.; Strum, W.; Wallraff, W. (Technische Hochschule Aachen (F. R. Germany). 1.; Physikalisches Inst.); Berkelman, K.; Cords, D.; Felst, R.; Gadermann, E. Phys. Lett., B; 57: No. 3, 297-300(7 Jul 1975).

Hadronic two body decays of the 3.1 GeV resonance were measured and the following branching ratios were obtained: $\Gamma_{\pi^+\pi^-}/\Gamma_{\mu\mu} < 0.0046$, $\Gamma_{K^+K^-}/\Gamma_{\mu\mu} < 0.0084$, and $\Gamma_{p\bar{p}}/\Gamma_{\mu\mu} = 0.036 \pm 0.010$ assuming the $p\bar{p}$ decay distribution is $\sim 1 + \cos^2\theta$. (auth)

**29426** LIMIT ON SCALAR-PSEUDOSCALAR WEAK NEUTRAL CURRENTS FROM A NEW INTERPRETATION OF ATOMIC ELECTRIC DIPOLE MEASUREMENTS. Bouchiat, C. (Ecole Normale Superieure, 75 - Paris (France)). Phys. Lett., B; 57: No. 3, 284-288(7 Jul 1975).

It is shown that the existing measurements of electric dipole moment of heavy atoms exclude a weak electron-nucleon interaction involving the product of a pseudoscalar and a scalar neutral current with a coupling constant larger than $10^{-3}$ $G_F$. (auth)

**29427** EFFECTIVE COUPLING CONSTANT EXPANSION OF THE MUON ANOMALOUS MAGNETIC MOMENT. Barbieri, R. (European Organization for Nuclear Research, Geneva (Switzerland)); Remiddi, E. (Ecole Normale Superieure, 75 - Paris (France)). Phys. Lett., B; 57: No. 3, 273-276(7 Jul 1975).

The relationship between the renormalization group and the muon anomalous magnetic moment calculation in QED is reconsidered. A very simple analysis shows that the contribution to the muon anomaly from muon vertex graphs with electron loop insertions in the photon propagators is function of only one dimensionless effective coupling constant $\alpha_\mu \simeq 1/136.0785$. The perturbative expansion coefficients up to the $\alpha_\mu^3$ term are given, and comparison is made with the previous calculations. (auth)

**29428** NEW QUARK MODEL FOR HADRONS. Harari, H. (Stanford Linear Accelerator Center, Calif. (USA)). Phys. Lett., B; 57: No. 3, 265-269(7 Jul 1975).

A new quark model is proposed for the hadron spectrum. It consists of six quarks - the usual triplet and a new antitriplet of heavy quarks, with electric charges +2/3, +2/3, −1/3. The ψ-particles are bound states of heavy $q\bar{q}$ pairs. Among many other predictions it is found that R = 5 in $e^+e^-$ scattering and $\Gamma(\psi \to e^+e^-) : \Gamma(\psi' \to e^+e^-) = 2:1$. The model naturally forbids neutral $\Delta S = 1$ weak currents and predicts a spectrum of heavy mesons and baryons. (auth)

**29429** MAGNETIC MOMENTS OF THE STRANGE BARYONS IN THE BAG MODEL. Allen, E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Physics). Phys. Lett., B; 57: No. 3, 263-264(7 Jul 1975).

SU(3) symmetry is broken in the bag model by giving the singlet quark a mass m. The magnetic moment ratios of the strange baryons are calculated and compared with exact SU(6) predictions and with experiment. (auth)

**29430** POMERON COUPLINGS AND THE DECAYS OF PSI' AND PSI. Clavelli, L. Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Phys. Lett., B; 57: No. 3, 257-259(7 Jul 1975).

Assuming that the ψ (3095) and ψ' (3685) are $\phi_c$ mesons, the effects on their decay modes of the dual model loop graphs which contain the quark line disconnected pomeron contributions are estimated. (auth)

**29431** CAYLEY NUMBER AND CONSERVATION LAWS FOR ELEMENTARY PARTICLES. Vollendorf, F. Z. Naturforsch., a; 30: No. 4, 431-433(Apr 1975). (In German).

It is shown that the five conservation laws of charge, hypercharge, baryon number and the two lepton numbers lead to the construction of a commutative non-associative 24 dimensional linear algebra. Each element of the algebra is an ordered set of three Cayley numbers. (auth)

**29432** GEOMETRICAL SCALING VS FACTORIZABLE EIKONAL MODELS. Kiang, D.; Takagi, F. (Dalhousie Univ., Halifax, Nova Scotia). Lett. Nuovo Cim.; 13: No. 12, 445-448 (19 Jul 1975).

Geometrical scaling (GS) and eikonal models with factorizable opaqueness are discussed, placing particular emphasis on the Chou-Yang model. It is shown that GS is incompatible with factorizable eikonal models under certain conditions. (SDF)

**29433** EVIDENCE FOR A FIXED J = 0 POLE IN PION COMPTON SCATTERING. Peterson, C. (Univ. of Lund, Sweden). Lett. Nuovo Cim.; 13: No. 12, 460-462(19 Jul 1975).

The elementarity of the photon suggests that Compton scattering might involve non-Regge singularities, that is, fixed poles in the complex angular momentum plane. Using an unsubtracted dispersion relation for pion Compton scattering, a sum rule is derived which favors a fixed J = 0 pole in the angular momentum plane with the value of its residue consistent with the Thomson limit, providing the vector dominance model is corrected by light cone contributions. (SDF)

**29434** MULTICLUSTER EXPANSION AND POMERON RENORMALIZATION EFFECTS. Manesis, E. K. (Univ. of Ioannina, Greece). Lett. Nuovo Cim.; 13: No. 12, 476-478(19 Jul 1975).

It is believed that the angular momentum plane singularity responsible for diffractive scattering cannot be a simple pole. Assuming that a simple pole bare pomeron dominates the so-called single fireball cross section and is exchanged between any pair of diffractively produced clusters, an integral equation of the Lippmann-Schwinger type is constructed to sum a class of bare pomeron loop diagrams. This procedure renormalizes the simple factorizable pole into a complex singularity of a cut and a simple pole. This composite is termed the actual multicluster pomeron. (SDF)

**29435** IS THE ABSENCE OF SEMI-INCLUSIVE CORRELATIONS COMPATIBLE WITH THE CLUSTER MODEL. Gula, A. (Rutherford Lab., Chilton, Eng.). Lett. Nuovo Cim.; 13: No. 11, 432-436(12 Jul 1975).

Using a natural model for cluster production in multiparticle processes, it is shown that correlations between clusters can be negative and tend to cancel the positive short range contribution reflecting the correlation between particles emerging from the same cluster. In the model considered, the result qualitatively resembles the independent production of particles. (SDF)

**29436** LINEAR DISPERSION BEHAVIOR OF A FRAGMENTATION MODEL. Loe, K. F.; Low, H. B.; Phua, K. K. (Nanyang Univ., Singapore). Lett. Nuovo Cim.; 13: No. 13, 493-496(26 Jul 1975).

An attempt is made to demonstrate a linear dispersion behavior within a fragmentation process with pionization always present. It is found that in this situation, Wroblewski's linear dispersion behavior can be obtained. (SDF)

**29437** PAIR PRODUCTION PROCESSES AND FINAL STATE INTERACTION. Yueh, W. R. New York; Columbia Univ (1974). 79p. University Microfilms Order No. 75-5268.

Thesis (Ph. D.).

Schwinger's formula for the probability of the spontaneous pair production in the presence of constant and homogeneous external fields is first rederived by using a quasi-classical method which treated the virtual pairs as being on-mass-shell but with imaginary momentum. This is analogous to considering the negative energy electrons undergoing a potential barrier penetration to emerge in the physical continuum states. Then this method, together with the quantum mechanical method and the proper time method, are generalized to include the final state Coulomb-type interaction. These three nonperturbative methods are used to calculate the final state interaction enhancement factor, which favors the bound state pair production, to all orders of the coupling constant within justifiable approximations. This formalism is generalized to include the case of Dirac magnetic monopole pair production by the super-strong pulser magnetic fields. The possibility of laboratory production of pole pairs at the focus of a high power, intense laser beam coherent fields which is still unattainable in the near future is also discussed. The application of this formalism to the production of lepton pairs, or even quarks, monopole and/or dyon pairs during the high energy collision processes is also included. (Diss. Abstr. Int., B)

**29438** COEFFICIENTS OF THE WICK EXPANSION AND THE TRANSMUTATIONAL SYMMETRY OF THREE-PARTICLE AMPLITUDES. Obrant, G. Z. (Leningrad Inst. of Nuclear Physics). Yadern. Fiz.; 21: No. 4, 902-911(Apr 1975). (In Russian).

The coefficients of the three-particle amplitude expansion in partial waves with a definite total momentum are obtained. For the case of two identical particles the transmutational properties of those coefficients and the partial wave expansion of the symmetrized amplitude are considered. (1 figure) (auth)

**29439** RELATIVISTIC FORM FACTORS OF COMPOSITE PARTICLES. Garsevanishvili, V. R.; Kvinikhidze, A. N.; Matveev, V. A.; Tavkhelidze, A. N.; Faustov, R. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 23: No. 3, 310-321(Jun 1975). (In Russian).

Theory of form factors of composite particles is developed on the basis of relativistically covariant quasipotential equations. (auth)

**29440** HIGH-ENERGY PHYSICS AND TECHNOLOGY. Skarek, P. (European Organization for Nuclear Research, Geneva (Switzerland)). Umsch. Wiss. Tech.; 75: No. 7, 212-213(Apr 1975). (In German).

A meeting on "Technology Arising from High-Energy Physics" was held in CERN in April 1974. This article discusses the proceedings of that meeting which include not only the review papers but also present concise notes on all 255 individual exhibit stands set up during the meeting. Short examples are given for some topics covered in the proceedings like high-precision alignment techniques, particle detectors, data handling, vacuum, superconducting coils, and computer control applied to accelerators. (auth)

**29441** ON THE RENORMALIZATION OF THE CHARM QUARTET MODEL. Marciano, W. J. (Rockefeller Univ., New York (USA). Dept. of Physics); Sirlin, A. (New York Univ., N. Y. (USA). Dept. of Physics). Nucl. Phys., B; 93: No. 2, 303-323 (21 Jun 1975).

Some aspects of the renormalization program for the charm quartet model are discussed, with special emphasis on the role played by the Cabibbo angle. The cancellation of divergences in the W-quarks and Higgs-quarks sectors is examined by explicit calculations at the one-loop level, both in the unitary and 't Hooft-Feynman gauges. The main analysis is based on a renormalization scheme which allows for the most general counter-terms generated by the Yukawa couplings. A second approach equivalent at the S-matrix level, is briefly discussed. As a byproduct of this work it is verified that the standard perturbative analysis leads to the same expression for the coefficients of the divergent parts in the renormalization of the gauge coupling $g_0$ as a recent current algebra formulation of the radiative corrections. (auth)

**29442** REINTERPRETATION OF THE RECIPROCITY THEORY OF ELEMENTARY PARTICLES. Chhajlany, S. C.; Kumar, N. (Univ., Liege). Lett. Nuovo Cim.; 13: No. 10, 364-366(5 Jul 1975).

The reciprocity theory of elementary particles developed by Born and collaborators is reinterpreted within the framework of conventional relativity. Mass spectrum results follow naturally on imposing a covariant restraint in a certain manner and previously unnoticed features are pointed out. It is suggested that in order to introduce further structure into the theory, the unspecified mass points might be identified with quarks. (SDF)

**29443** JOINT RAPIDITY-AZIMUTHAL CORRELATIONS AND THE BOSE EFFECT IN CLUSTER MODELS. Ranft, J.; Ranft, D. (Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik). Phys. Lett., B; 57: No. 4, 373-375(21 Jul 1975).

The cluster model with Bose effect explains rather well recent FNAL data on $(\Delta y, \Delta\phi)$ correlations at $\Delta y = \Delta\phi = 0$ of identical particles. To test this interpretation more in detail, transverse momentum limitations are proposed which should enhance the effect. It is pointed out that the conventional cluster analysis of $\Delta y$ correlation data is only justified with data around $\Delta\phi = \pi$. (auth)

**29444** TRANSVERSE MOMENTUM STRUCTURE OF PRODUCTION AMPLITUDES. Michael, C. (Liverpool Univ. (UK)). Phys. Lett., B; 57: No. 4, 379-383(21 Jul 1975).

A general structure for transverse momentum dependence of production amplitudes is proposed. Observable azimuthal correlations, the slope of elastic scattering and specific multiperipheral and cluster models are discussed. (auth)

**29445** THE SIGMA-MODEL AND ITS RENORMALIZATION IN A DIMENSIONALLY REGULARISED NORMAL PRODUCT FORMULATION. Collecott, P. S.; Collins, J. C. (Cambridge Univ. (UK). Dept. of Applied Mathematics and Theoretical Physics). Nucl. Phys., B; 93: No. 2, 217-236(21 Jun 1975).

The $\sigma$-model is re-examined in the light of the reformulation of the normal product method in dimensional regularization. It is considered both as a prime example of, and testing ground for, these methods, and to display the dimensionally regularized renormalization of the model. Explicit and spontaneous symmetry breakings are considered, and the PCAC relation and Goldstone theorem are examined and proved in the one loop approximation. The renormalization group equation coefficients are also obtained to this order. Both arbitrary (renormalized) parametrizations, and the mass shell parametrization with finite counterterms are considered. It is found that, in contrast with other treatments, these counter terms remain finite in the infrared limit of a massless symmetric Lagrangian. (auth)

**29446** CONFINED QUARKS, BJORKEN SCALING AND CURRENT ALGEBRA. Polkinghorne, J. C. (Cambridge Univ. (UK). Dept. of Applied Mathematics and Theoretical Physics). Nucl. Phys., B; 93: No. 3, 515-524(28 Jul 1975).

A simple model of confined quarks is presented which resembles the massive quark model in the calculation of structure functions and which has the property that it is manifestly consistent with current algebra. (auth)

**29447** PHENOMENOLOGICAL TESTS OF f-DOMINATED POMERON IN INCLUSIVE REACTIONS. Inami, T. (Paris-11 Univ., 91 – Orsay (France)); Roberts, R. G. (SEE CODE-5677710 Science Research Council, Chilton (UK). Rutherford High Energy Lab.). Nucl. Phys., B; 93: No. 3, 497-514(28 Jul 1975).

Results of an analysis of data on several inclusive processes which test the hypothesis of f-dominance of the pomeron (FDP) are presented. Both nondiffractive and diffractive reactions are studied. In the first case a comparison of pairs of fragmentation processes (one exotic, the other nonexotic) are considered so that the pomeron and f-exchange contributions can be estimated and their ratio compared with that obtained from total cross sections. It is found that the f : P ratio is largely independent of both t and $M^2/s$ and its value is consistent with that given by total cross sections, thus giving strong support to the FDP hypothesis. For the diffractive inclusive process, the hypothesis relates all the couplings PPP, PPM, MMP, MMM and the interference term PMP to one overall coupling. A triple-Regge analysis of the world data on pp → pX is carried out using the FDP couplings together with $\pi$-exchange contributions which are consistent with the pn → pX data. Good agreement is obtained with the data and with conventional triple-Regge fits (which have no constraints on the couplings) except for small t. The data at small t, including the pd → dX data, almost scale with energy and require a substantially smaller value of PPM/PPP than that according to the FDP hypothesis. On the whole, however, it is felt that the predictions of FDP for inclusive reactions are experimentally well satisfied for a wide class of data. (auth)

**29448** RAPIDITY GAP DISTRIBUTIONS AND CLUSTERING IN MULTIPARTICLE PRODUCTION. Krzywicki, A.; Quigg, C. (Fermi National Accelerator Lab., Batavia, Ill. (USA)); Thomas, G. H. (Argonne National Lab., Ill. (USA)). Phys. Lett., B; 57: No. 4, 369-372(21 Jul 1975).

A general formula is obtained for the rapidity gap distribution in short-range order models and the exponential slope at large gaps is related to the behavior of topological cross sections. (auth)

## Electromagnetic

*Refer also to abstracts 29311, 30024, 30034, and 30058.*

**29449** (CERN-75-11) POLARIZED PARTICLES FOR ACCELERATOR PHYSICISTS. Bell, J. S. (European Organization for Nuclear Research, Geneva (Switzerland)). 16 Sep 1975. 43p. Dep. NTIS (US Sales Only) $5.25.

These lectures deal in an elementary way with the concept of particle polarization and its behavior in the presence of electromagnetic fields. The basic notions and essential equations are introduced in a purely phenomenological way, beginning with spin-½ particles and then extending the discussion to particles of arbitrary spin. Among the topics discussed are magnetic precession and the muon g-2 experiment. An introduction is given to nonrelativistic wave mechanics, and then the quantum-theoretic interpretation of the phenomenological equations is developed for particles with spin ½, 1, and higher. (auth)

**29450** (CONF-730750-, pp L1-L8) POSITRON–ATOM INTERACTION. Hewson, P. W. (Univ. of Witwatersrand, Johannesburg); Vogt, E. W. Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

A study is made of the problem of understanding those conditions which determine whether or not an electron and a positron will form a suitable annihilation pair. In particular, positron annihilation in noble gases is considered. It is found that by solving the scattering problem of a positron off an atom, one can calculate annihilation rates very successfully. A simple model, based on the local density approximation for the electron is used, which allows one to incorporate correctly the all important short range correlations between positrons and electrons without the use of parameters. (JFP)

**29451** (COO-1545-162) SUPERSYMMETRIC GAUGE MODEL OF THE ELECTRON AND ITS NEUTRINO. Mainland, G. B.; Tanaka, K. (Ohio State Univ., Columbus (USA). Dept. of Physics; Stanford Linear Accelerator Center, Calif. (USA); Helsinki Univ. (Finland). Dept. of Theoretical Physics). 1975. Contract E(11-1)-1545. 11p. (SLAC-PUB-1639). Dep. NTIS $4.00.

A supersymmetric SU(2) x SU(1) gauge model for the electromagnetic, weak, and neutral weak interactions of the electron is constructed. After masses are created via spontaneous symmetry breaking, the electron and its neutrino remain massless to lowest order while a heavy electron and an accompanying neutral lepton acquire masses comparable respectively to those of the intermediate vector bosons W/sub ←//sup mu/ and Z/sup mu/. Lepton number is conserved in a natural way without requiring bosons to carry lepton number. (auth)

**29452** (EFI-62(74)) INCOHERENT SCATTERING OF HIGH-ENERGY PHOTONS ON NUCLEI. Gevorkyan, S. R.; Zhamkochyan, V. M.; Koval', L. N.; Matinyan, S. G. (Erevanskij Fizicheskij Inst. (USSR)). 1974. 7p. INIS.

7 refs.

The incoherent Compton-effect on nuclei is considered in the framework of multiple scattering theory to explain the experimental value of $A^{0.9}$ for the A-dependence of $\delta(\gamma A)$. Besides the direct process of elastic scattering of photons, one considers contributions from discreet intermediate channels due to the photoproduction of vector mesons $\rho^0$ and $\omega$ on a single nucleon with their subsequent transition to photon. Supposing the validity of vector dominance model, one obtains that the differential cross section of $\gamma A$ scattering is equal to the cross section of the quasi-elastic scattering of hadrons on nuclei. It follows hence that the photon lifetime in a hadron state increases with the increase of energy. Since the cross section for quasi-elastic scattering of hadrons on nuclei varies with the increase of A approximately as $A^{\frac{1}{3}}$, the deviation from this dependence in the high energy region ($1 \ll S$) is determined by the difference of the parameter W from unity (W characterizes the validity of vector dominance model). (auth)

**29453** (EFI-63(74)) $\pi^0$-MESON PHOTOPRODUCTION ON $^4$He NUCLEUS IN THE REGGE POLE MODEL WITH CUTS. Grigoryan, L. A.; Shakhbazyan, V. A. (Erevanskij Fizicheskij Inst. (USSR)). 1974. 19p. (In Russian). INIS.

8 refs.; 3 figs.; 2 tables.

The process of $\pi^0$ meson production on the $^4$He nucleus is considered within the framework of the Regge pole theory and considering Regge branching in "strong," "weak," and "mixed" sections and in a model of phenomenological calculation of sections. With this process, a concrete model can be selected by comparing the results with experimental data. In calculations on the nuclear part of the amplitude of the process, the contribution of all invariant amplitudes of the $\pi^+$ meson interaction with the nucleon are considered. The behavior of the differential

cross sections depends strongly on the model selected. The differential cross sections can be used to verify the accuracy of the different models of the theory of complex moments. (tr-auth)

**29454** (RL-75-122) RELATING INCLUSIVE AND EXCLUSIVE MESON PHOTOPRODUCTION AT LARGE TRANSVERSE MOMENTUM. Scott, D. M. (Science Research Council, Chilton (UK). Rutherford Lab.). Jul 1975. 14p. Dep. NTIS (US Sales Only) $4.00.

Inclusive and exclusive meson photoproduction at large transverse momentum are related by a local application of the correspondence principle of Bjorken and Kogut. The recent predictions for the inclusive process by Escobar are thus compared with wide angle exclusive data. The inclusive photoproduction of $(\rho^0 + \omega)$ at large transverse momentum is discussed. (auth)

**29455** UNIFIED DISPERSION MODEL FOR PROCESSES LIKE THE PION PHOTOPRODUCTION NEAR THE $\Delta(3/2, 3/2)$ RESONANCE. Blokhintseva, T. D.; Surovtsev, Yu. S.; Tkebuchava, F. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 4, 850-860(Apr 1975). (In Russian).

Processes $\gamma N \to \pi N$, $eN \to e\pi N$ and $\pi N \to e^+e^-N$ in the energy region of the $\Delta(3/2,3/2)$ resonance are considered in framework of the dispersion relations. Problems related to the possibility to determine the electromagnetic form factors of pions and nucleons are discussed. (7 figures) (auth)

**29456** PHOTOPRODUCTION OF $\phi$-MESONS. Zakharov, V. I.; Ioffe, B. L.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1635-1639(May 1975). (In Russian).

Possible causes of the smallness of the $\phi$-meson photoproduction cross section are discussed: suppression due to smallness of the scattering cross section of a real $\phi$-meson due to the small magnitude of the residue of the Pomeranchuk trajectory; suppression due to inability of a virtual $\phi$-meson to produce a pomeron shower during a time $E_\gamma/m_\phi^2$ and hence the diffraction transition of a virtual $\phi$ with $q^2 = 0$ into a real one with $q^2 = m_\phi^2$ is small; suppression due to smallness of the transition $\phi \to \gamma$; in this case the vertex $g_{e\phi\gamma}\bar{e}\gamma_\mu e$ is primary and not due to a virtual photon. It is shown that a choice between these possibilities can be made by studying experimentally electroproduction of $\phi$-mesons and their photoproduction by nuclei. (auth)

**29457** INVESTIGATION OF INTERACTION BETWEEN ELECTRONS AND A BOUNDARY BY MEANS OF TRANSVERSE FOCUSING. Tsoi, V. S. (Inst. of Solid State Physics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1849-1858(May 1975). (In Russian).

A method is developed for measuring the electron reflection specularity coefficient q for a boundary which is based on focusing the electrons in a metal by a transverse homogeneous magnetic field. The coefficient q for electrons normally incident on the boundary can be determined by the method and the dependence of q on angle of incidence $\theta$ can be found. Results of measurement in bismuth are presented. (auth)

**29458** COMPENSATION EFFECT IN PION PHOTOPRODUCTION AND RELATED PROCESSES AND POSSIBILITY OF INVESTIGATION OF HADRON ELECTROMAGNETIC FORM FACTORS. Surovtsev, Yu. S.; Tkebuchava, F. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 4, 753-756 (Apr 1975). (In Russian).

It is shown for process $\gamma N \to \pi N$ that in the physical region of variables of the production amplitude there exist continuous curves along which the differential cross section is completely determined by the Born terms. Possibility of using such curves to reveal the optimal experimental conditions for extracting the model-independent values of the hadron electromagnetic form factors from processes $eN \to eN\pi$ and $\pi N \to e^+e^-N$ is discussed. (1 figure) (auth)

**29459** PRODUCTION OF TRIPLETS BY HIGH ENERGY POLARIZED PHOTONS. Vinokurov, E. A.; Merenkov, N. P. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 21: No. 4, 781-784(Apr 1975). (In Russian).

The recoil electron distribution and the energy distribution of one of the pair components as well as the positron (electron) spectrum in the case when the recoil momentum is being fixed beginning from some value $q_0$ on the order of $m_e$ are obtained for production of triplets by high energy polarized photons. This spectrum has an azimuthal symmetry and can be used to determine the polarization degree of a high energy photon beam. (2 figures) (auth)

**29460** TESTS OF THE SPACE-TIME PROPERTIES OF NEUTRAL CURRENTS IN ELECTRON-POSITRON ANNIHILATION. Dass, G. V.; Ross, G. G. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 57: No. 2, 173-176(23 Jun 1975).

Electron-positron processes are very valuable for investigating neutral currents. Interference between neutral currents and the electromagnetic current provides unambiguous tests of the space-time properties of neutral currents. The structure of this interference is discussed with particular reference to the process $e^+e^- \to$ hadron + anything. (auth)

**29461** CLASSICAL DYNAMICS FOR CHARGED PARTICLES. Goedecke, G. H. (New Mexico State Univ., Las Cruces). Nuovo Cim., B; 28B: No. 1, 225-243(11 Jul 1975).

The requirement that there be zero net electromagnetic energy-momentum flux passing through a spherical surface of radius $r_0$ bounding and comoving with a stable charge-current distribution leads to a new classical equation of motion for the center point of the distribution. For any spherically symmetric distribution of charge q, rest mass m, in the nonrelativistic limit the new motion equation reduces to the Abraham-Lorentz equation, with Lorentz external force, for all external fields with wave lengths $\lambda \gg r_0$, and field strengths $\ll |q|/r_0^2$, provided $r_0 = 2q^2/3mc^2$. Only retarded fields are used. (auth)

**29462** INTERACTING FERMIONIC AND POMERONIC STRINGS: GRAVITATIONAL INTERACTION OF THE RAMOND FERMION. Yoneya, T. (Hokkaido Univ., Sapporo). Nuovo Cim., A; 27A: No. 4, 440-457(21 Jul 1975).

We present a ghost-free model for the Ramond fermion interacting with closed and open bosonic strings. Since a closed string contains a graviton state as a physical state, which reduces to the Einstein graviton in the zero-slope limit, we introduce the interaction of the closed-string graviton with the fermionic string of Ramond in a way analogous to the usual tetrad formalism for the interacting gravitational and spinor fields. By considering the general co-ordinate transformation and the local Lorentz transformation for the fermionic string, we obtain the vertex for an external tetrad field. We show that the vertex satisfies desirable gravitational and supergauge properties. A general form of the vertices describing the emission of the closed string out of the fermionic string is given by extracting the gauge properties of the graviton vertex. In our model, the self-interaction among the closed strings is described by the nonplanar version of the Neveu-Schwarz model. The zero-slope limit is also briefly considered. (auth)

**29463** KHURI-TREIMAN MODEL OF ETA $\to 3\pi$ AND K $\to 3\pi$ DECAYS. Angus, A. G.; Graves-Morris, P. R. (Univ. of Kent, Canterbury, Eng.). J. Phys., G (London); 1: No. 5, 487-492(20 Jun 1975).

Using the Khuri-Treiman model, it is confirmed that the gross features of the spectra of $\eta \to 3\pi$ and K $\to 3\pi$ decays can be explained quantitatively in terms of a point interaction for the production vertex and $\pi\pi$ final state interactions. Allowances are made for relativistic effects and Coulomb effects, but multiple rescattering corrections and violation of the $\Delta I = \frac{1}{2}$ rule are ignored. S wave pionic amplitudes given by an improved N/D model with some crossing symmetry properties incorporated through Roskies' relations are used, and the decay amplitudes are deduced from Khuri-Treiman theory. (auth)

**29464** ELECTROMAGNETIC SOLUTIONS FROM VACUUM FIELDS. Singh, T. (Univ. of Gorakhpur, India). J. Phys., A. (London); 8: No. 8, 1361-1363(Aug 1975).

Applying Harrison's result (Phys. Rev.; 138B: 488-94 (1965)) to the empty space solutions of Taub (Ann. Math. NY; 53: 472-90 (1951)) and Das (J. Math. Phys.; 12: 1136-42 (1971)) both due to the gravitational field of an infinite plane, the corresponding solutions of the Einstein-Maxwell equations were obtained. These solutions represent fields due to infinite charged planes. (auth)

**29465** METRIC AND GRAVITATIONAL MASS OF INTERACTING CHARGED PARTICLES AT REST. Pechlaner, E. (Simon Fraser Univ., Burnaby, B. C.). J. Phys., A (London); 8: No. 6, 863-873(Jun 1975).

An axisymmetric static system of charged point particles is investigated in the framework of general relativity. The particles are located on the axis of symmetry; the Einstein-Maxwell equations are solved in second approximation. Equilibrium is maintained by means of "struts" connecting neighboring particles. Assumptions are made which make the solution unique. The mass of the whole system and the gravitational mass of individual particles are defined. It is found that the change in gravitational mass of an individual particle with charge Q due to the presence of the other particles is equal to $-\frac{1}{2}Q\phi$ where $\phi$ is the electric potential produced by the remaining particles on the location of the particle. This result, which is expected to hold even if the system does not have axial symmetry, should be obtainable from Einstein's linearized theory and the above mentioned assumptions. (auth)

**29466** RELATIVITY AND AN EXPERIMENT ON HIGH VELOCITY PARTICLES. Thomsen, P. (Royal Danish School of Educational Studies, Copenhagen). Phys. Educ.; 10: No. 5, 364-366 (Jul 1975).

A simple experiment is described to demonstrate the inadequacy of classical dynamics and the ability of relativistic dynamics to describe the motion of electrons whose energy ranges up to 10 keV (1.6 fJ). The rationale of the experiment is that classical and relativistic mechanics predict different trajectories for the motion of a charged particle within a static electric field. In the experiment a high sensitivity is achieved with modest experimental equipment by using a method where only a small deviation from a comparatively large stationary effect is measured. The slight variation of the trajectory, or rather of a single point of it, is the quantity actually measured. (UK)

**29467** POSSIBLE IMPLICATIONS OF A LARGE SIGMA/sub T/ ($e^+e^-$ yields HADRONS). Fryberger, D. (Stanford Linear Accelerator Center, CA). Lett. Nuovo Cim.; 13: No. 16, 610-612 (16 Aug 1975).

Consequences of the anomalously high ratio of total hadronic cross section for ($e^+e^-$ yields hadrons) to the cross section for ($e^+e^-$ yields $mu^+mu^-$) at beam energies E greater than 1.5 GeV are examined. In particular, the notion that the electron may have intrinsic hadronic aspects is considered. (SDF)

**29468** RELATIVISTIC QUARK MODEL AND SCALING. Blagojevic, M. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Lett. Nuovo Cim.; 13: No. 12, 437-440(19 Jul 1975).

It has been found that the behavior of the nucleon resonances' form factors in electroproduction is consistent with the finite energy sum rules derived by Bloom and Gilman on the basis of scaling and duality. The analysis uses the symmetric harmonic oscillator three-quark model based on the relativistic wave equation, in which the relative motion of the quarks inside the resonance is nonrelativistic, and the motion of the resonance as a whole is treated relativistically. (SDF)

**29469** ANALYSIS OF $e^+e^- \rightarrow$ PSI-PRIME PSI AND THE EPSILON RESONANCE. Decker, R.; Moreno, M. (Univ., Louvain, Belg.). Lett. Nuovo Cim.; 13: No. 11, 407-410(12 Jul 1975).

A model of the interaction $e^+e^- \rightarrow$ psi (3.7) $\rightarrow$ psi (3.1) $\pi\pi$ is proposed, making the following assumptions: (1) psi (3.1) and psi (3.7) are vector particles such that $I_G = O^-$; (2) the interactions between psi (3.1) and psi (3.7) are parity and G parity conserving; (3) X (3.1) comes from decay of psi (3.1); (4) the only resonance state which may mediate the interaction between the psi's is the eta (700) resonance. Recent data tend to agree with the model presented. (SDF)

**29470** RADIATIVE CORRECTIONS TO $e^+e^- \rightarrow mu^+mu^-$ NEAR A NARROW VECTOR RESONANCE. Altarelli, G.; Ellis, R. K.; Petronzio, R. (Univ., Rome). Lett. Nuovo Cim.; 13: No. 11, 393-400(12 Jul 1975).

The forward-backward asymmetry for $e^+e^- \rightarrow \mu^+\mu^-$ in the vicinity of a narrow resonance such as psi-3105 or psi-3695 is evaluated. Assuming the psi's are pure $1^-$ states, this asymmetry is due to radiative corrections. A universal vector coupling is assumed and the cross section is computed to third order. The validity of the soft photon approximation is discussed. (3 figures) (SDF)

**29471** ELECTROMAGNETIC MASS DIFFERENCES OF $\pi$-MESONS. I. Palla, L. (Lorant Eotvos Univ., Budapest). Magy. Fiz. Foly.; 22: No. 6, 499-510(1974). (In Hungarian).

The electromagnetic mass differences of $\pi$ mesons were calculated under consideration of the gravitational interaction; the strong interaction was handled in a model-independent manner. After examining the theoretical bases of mass differences, divergent mass differences were derived for $\pi$ mesons; the effect of gravitation on pions was then examined on the basis of the pion difference; a modification of the Weinber II rule was applied. The logarithmically divergent character of the pion mass difference was not considered surprising, as J. D. Bjorken has reported a logarithmically divergent component in the electromagnetic mass difference of hadrons. (Diploma thesis). (TTT)

**29472** STRUCTURE FUNCTIONS OF AN INFINITE COMPONENT FIELD THEORY. Schneider, C. K. E. (Freie Univ. Berlin (F. R. Germany). Inst. fuer Theorie der Elementarteilchen). Z. Phys., A; 273: No. 1, 105-109(May 1975).

3 figs.; 12 refs.

The electomagnetic structure functions $F_3$(zeta) for deep inelastic electron-proton scattering are calculated for the most general second order wave equation constructed on an irreducible fermion representation space of the Lorentz group extended by parity. The results show scaling and a realistic size of the physical particles but a strong unphysical part due to spacelike solutions. (auth)

**29473** CONFORMAL MOMENTUM OF ELECTROMAGNETIC FIELD. Pestov, A. B.; Chernikov, N. A.; Shavokhina, N. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 23: No. 3, 331-334(Jun 1975). (In Russian).

Conformal momentum of electromagnetic field is studied. A scalar product in the space of solutions of the Maxwell equations is introduced. The theorem about the integral of the electromagnetic energy-momentum tensor is proved. The rules of quantization of the electromagnetic field in any Riemann world are formulated. Conformal invariance of the photon behavior is established. (auth)

**29474** PION MASS DIFFERENCE IN UNIFIED GAUGE THEORIES IN THE LIGHT-CONE REGION. Palla, L. (Roland Eotvos Univ., Budapest). J. Phys., G (London); 1: No. 6, 606-612 (1 Aug 1975).

The mass shift of pions is discussed in a general class of unified gauge field theories of weak and electromagnetic interactions to second order of the coupling constants and to $g_i^2/m_i^2$ order, respectively. The contributions of both the leading and the next to leading light-cone singularities (quark mass terms) are calculated, and it is shown that they do not give any divergent contribution to the pion mass difference. (auth)

**29475** MEASUREMENT OF THE SPECIFIC CHARGE OF THE ELECTRON BY THE DEVIATION COMPENSATION METHOD IN HOMOGENEOUS MAGNETIC AND ELECTRICAL FIELDS. Dluzhnevskii, G. I. (Moscow Inst. of Radiotechnology, Electronics, and Automation). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 146-148(1975). (In Russian).

The deviation of an electron in cathode ray tube under the effects of the electrical field of a compensator and the earth's magnetic field is considered and the equations describing its deflection are derived. A mounting making it possible to fix the electric field of the compensator perpendicularly to the earth's magnetic field is described for the measurement of the electron charge. (JSR)

**29476** THREE-PHOTON ANNIHILATION OF ELECTRON-POSITRON PAIRS. Smirnov, A. I. (Kostroma State Pedagogical Inst., USSR). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 126-127(1975). (In Russian).

An analysis of the three-photon annihilation of electron-positron pairs shows that in the ultrarelativistic energy region of all particles in the center of inertia system, the total cross section for this reaction will be, at the least, no less than the corresponding cross section of the two-photon pair annihilation. (JSR)

**29477** MODEL-INDEPENDENT PREDICTIONS OF WEINBERG'S THEORY FOR NEUTRINO–NUCLEON REACTIONS. Bender, I.; Gromes, D. (Univ., Heidelberg). Lett. Nuovo Cim.; 13: No. 10, 367-371(5 Jul 1975).

Neutral currents in high energy neutrino reactions are considered as a strong support for a gauge theory of weak and electromagnetic interactions based on the gauge group SU(2L) × U(1). Some predictions are made which are sensitive only to the SU(2L) × U(1) structure of the gauge theory but hold for all popular quark models. The essential point for such model independent predictions is that the right hand part of the neutral current depends only on the charge matrix. (SDF)

**29478** RARE ELECTROMAGNETIC DECAYS OF PIONIC ATOMS. Ericson, T. E. O.; Wilkin, C. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 57: No. 4, 345-348(21 Jul 1975).

It is shown that the virtual decay $\pi^0 \rightarrow 2\gamma$ inside a nucleus, and the annihilation reactions $\pi^- + \pi^+ \rightarrow 2\gamma$ or $e^+e^-$ on virtual pions in nuclei (the pionic analogies of positron annihilation in solids) have observable branching ratios. These processes should shed light on the micro-structure of the pion optical potential and on the nuclear pionic field with its coupling and to nucleonic excitation modes. Additionally, the $e^+e^-$ mode will allow one to measure axial nuclear form factors in contrast to the fixed points of radiative capture. (auth)

**29479** EXCHANGE-COMPONENT ANALYSIS OF NEUTRAL PSEUDOSCALAR MESON PHOTOPRODUCTION. Irving, A. C.; Vanryckeghem, L. G. F. (Liverpool Univ. (UK)). Nucl. Phys., B; 93: No. 2, 324-344(21 Jun 1975).

The $\pi^0$ and $\eta$ photoproduction data in the region of 4 GeV are decomposed into t-channel exchange components of definite isospin and parity. The latter are discussed in terms of Regge exchange models and compared to vector-meson dominance related processes. The isospin-one natural parity-exchange component is smooth and structureless. The dominant unnatural parity exchange in $\pi^0$ photoproduction has isospin zero. As in $\pi^+$ photoproduction

the ratio of natural to unnatural parity exchange is found to be larger than the vector-dominance expectation. Complementary information from a recent spin decomposition of $\gamma p \rightarrow \pi^0 p$ gives further insight into the SU(3) properties of the exchanges. Unmeasured quantities are predicted and the importance of studying $\gamma n \rightarrow \pi^0 n$ with polarized photons is stressed in particular. (auth)

**29480** ELECTRON-POSITRON ANNIHILATION ABOVE 2GeV AND THE NEW PARTICLES. Feldman, G. J.; Perl, M. L. (Stanford Linear Accelerator Center, Calif. (USA)). Phys. Rep.; 19: No. 5, 233-293(Aug 1975).

The experimental and phenomenological aspects of electron-positron annihilation into hadrons at center-of-mass energies above 2 GeV is reviewed. The behavior of the total cross section for hadron production as a function of energy is described; and the important parameter R--the ratio of this cross section to the muon-pair production cross section--is discussed. Data on charged particle multiplicities, particle production ratios, and single particle inclusive distributions are also summarized. Then the knowledge of the newly discovered psi particles is summarized; and the various theories are examined as to their nature and their relation to conventional hadronic physics. (auth)

## Weak

*Refer also to abstracts 29012 and 29947.*

**29481** (CERN-74-22, pp 1-222) WEAK INTERACTIONS. Jarlskog, C. Oct 1974.

From 1974 CERN school of physics; Windermere, UK(16 Jun 1974).

In proceedings of the 1974 CERN school of physics, Windermere, UK, 16-29 June 1974. (European Organization for Nuclear Research, Geneva (Switzerland)).

A summary is given of the well established parts of weak-interaction theory, i.e. at low energy and low momentum transfer, from the point of view of the experimental physicist. After a discussion of lepton selection rules, present knowledge is summarized of purely leptonic processes, especially muon decay, and the current-current theory of leptonic weak interactions. Beta-decay processes are considered, mainly in relation to neutron decay, with the vector and axial-vector nature of the interaction implied by experimental results. The conserved (iso) vector current hypothesis is discussed at some length. Two-body decay modes of pions and kaons, and selection rules for semileptonic processes are considered, and a survey is given of the Cabibbo theory of weak interactions. After a summary of the triumphs and shortcomings of the conventional theory, consideration is given to more recent aspects, notably neutral currents, vector bosons, heavy leptons, and charm particles. (auth)

**29482** (CERN-74-22, pp 180-212) NEUTRINO INTERACTIONS. Perkins, D. M. Oct 1974.

From 1974 CERN school of physics; Windermere, UK(16 Jun 1974).

In proceedings of the 1974 CERN school of physics, Windermere, UK, 16-29 June 1974. (European Organization for Nuclear Research, Geneva (Switzerland)).

Theoretical ideas on inclusive charge-changing weak currents and on neutral weak currents are summarized in relation to the latest experimental results. Inclusive charge-changing neutrino interactions are discussed essentially from the point of view of the parton and quark models. Neutral weak currents are treated in the context of renormalization in weak-interaction theory and the Salam-Ward-Weinberg unified theory of weak and electromagnetic interactions. Apparent contradictions between the two types of currents, and the possible ways to restore them, are discussed in each case. (auth)

**29483** (IC-75/106) QUARKS, LEPTONS, AND PRE-QUARKS. Pati, J. C.; Salam, A. (International Centre for Theoretical Physics, Trieste (Italy)). 1975. 18p. (CONF-750654-14). Dep. NTIS (US Sales Only) $4.00.

From high energy particle physics divisional conference of EPS; Palermo, Italy (23 Jun 1975).

Experimental consequences of the unification hypothesis combining color, charm, and mirror are discussed including an interpretation of the J/$\psi$ particles in terms of the new quantum numbers in the scheme, an explanation of the $\bar{\nu}$-y-distribution anomaly through a mirror helicity-flip coupling, recent calculations on decay rates and selection rules for decays of integer-charge colored quarks with the hope that these might be helpful in discovering the fundamental constituents, the quarks, and lastly the suggestion that quarks and leptons themselves are made out of pre-quarks and pre-bosons. (JFP)

**29484** (ISS-P-75/4) WEAK NONLEPTONIC DECAYS OF CHARMED HADRONS. Altarelli, G.; Cabibbo, N.; Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 10 Mar 1975. 14p. Dep. NTIS (US Sales Only) $4.00.

Weak nonleptonic decays of charmed hadrons are studied in the SU(4) quark model with color. Relations for baryon decays following from a specific SU(3) behavior of the effective hamiltonian, proposed previously, are presented and discussed. Consideration of the exact SU(4) limit leads to an estimate of the absolute widths of charmed baryons, and to a new relation among hyperon decay S-wave amplitudes, found to be violated to approximately 40%. (auth)

**29485** (JINR-P2-9020) QUARK-PARTON MODEL OF THE SYMMETRY BREAKING AND SPECTRAL SUM RULES. Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 12p. Dep. NTIS (US Sales Only) $4.00.

The model of breaking of the unitary symmetry for a parton-parton interaction is used to derive the modified Weinberg sum rules. The pole saturation of the modified sum rules leads to the model of mass mixing of the system $\omega-\phi$ and to appearance of an essential correction in the ratios for constants of lepton decays of strange mesons. (auth)

**29486** (JINR-P2-9037) $\mu \rightarrow 3e$, $\mu \rightarrow e + \gamma$ DECAYS IN THE NONLOCAL THEORY OF WEAK INTERACTIONS. Dineikhan, M.; Namsrai, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only $4.00.

The decays $\mu \rightarrow 3e$ and $\mu \rightarrow e + \gamma$ were studied in the framework of the nonlocal theory of weak interactions. It is assumed that the degree of discernibility $\nu_e - \nu_\mu$ depends on l -elementary length of the long weak interactions and on the nonlocal model form factor. The bounds for $l \leq 10^{-15}$cm were obtained for the case when $\nu_e$ and $\nu_\mu$ are not absolutely identical particles. The latter fact was established in experimental way. (auth)

**29487** (JINR-P2-9038) CALCULATION OF THE HIGH ORDER CORRECTIONS OF THE PERTURBATION THEORY FOR THE MESON DECAY IN THE NONLOCAL QUANTUM FIELD THEORY. Dineikhan, M.; Namsrai, Kh.; Omboo, Z. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 23p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

The $K_L^* \rightarrow \mu^+\mu^-$ decay rate is investigated within the framework of nonlocal quantum field theory of the weak interactions. Bounds were derived for the $l \lesssim 10^{-16}$ cm (for the decay $K_L^* \rightarrow \mu^+\mu^-$) by means of appropriate selection for the form factors of the nonlocal model. The quantity $l \approx 1/\Lambda$ is an elementary length determining the domain where the weak interactions become nonlocal. Some possibility of existence of an anomalous interaction between the leptons at high energy is also discussed. (auth)

**29488** (JINR-P2-9082) LEPTON SELF MASS. Bardin, D. Yu.; Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1975. 15p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The charge lepton self masses are calculated in the second order of four fermion weak interactions under assumption that the "bare" mass of one neutrinos is not zero. The mass splitting of charged leptons thus calculated turned out to be very small. (auth)

**29489** BREMSSTRAHLUNG PRODUCTION OF PION AND MUON PAIRS IN COLLIDING $e^+-e^-$BEAMS. Kotkin, G. L.; Serbo, V. G. (Novosibirsk State Univ., USSR). Yadern. Fiz.; 21: No. 4, 785-792(Apr 1975). (In Russian).

The differential cross section for bremsstrahlung production of pion (muon) pairs in the reaction $e^+e \rightarrow e^+e\pi^+\pi^-(\mu^+\mu^-)$ is obtained in the logarithmic approximation. For the pions emitted in a direction near the initial electron momentum $p_1$ this cross section depends essentially on the momentum transfer $u = (p_1-k)^2$, $k = k_{\pi^+} + k_{\pi^-}$($d\sigma_1 \propto u^{-2}$). The distributions in the noncoplanarity angle of the pion pair and in the total 4-momentum k are also found. Comparison with the two-photon pair production cross section $d\sigma_2$ is carried out. The ratio $d\sigma_1/d\sigma_2$ is small for those pair energies that are not too large, and is big for the high energies. (3 figures) (auth)

**29490** TWO-PHOTON AND ONE-PHOTON ANNIHILATION $e^+e^- \rightarrow$ HADRONS. Ginzburg, I. F.; Meledin, G. V.; Serbo, V. G. (Inst. of Mathematics, Moscow). Yadern. Fiz.; 21: No. 4, 793-795(Apr 1975). (In Russian).

The cross section of the two-photon annihilation $e^+e^- \rightarrow$ hadrons is shown to be negligibly small as compared to the single-photon annihilation in a large energy region. (1 figure) (auth)

**29491** POLARIZATION OF PROTONS IN ELASTIC $\nu p$ SCATTERING. Shchepkin, M. G. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 21: No. 4, 796-798 (Apr 1975). (In Russian).

The longitudinal and transverse polarization of recoil protons in the elastic $\bar{\nu}p$ scattering is calculated in the framework of the Weinberg's model with neutral currents. (2 figures) (auth)

**29492** WEAK NON LEPTONIC DECAYS OF CHARMED HADRONS. Altarelli, G.; Cabibbo, N. (Rome Univ. (Italy). Istituto di Fisica); Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Phys. Lett., B; 57: No. 3, 277-280(7 Jul 1975).

Weak nonleptonic decays of charmed hadrons are studied in the SU(4) quark model with color. Relations for baryon decays following from a specific SU(3) behaviour of the effective hamiltonian, proposed in a previous paper, are presented and discussed. Consideration of the exact SU(4) limit leads to an estimate of the absolute widths of charmed baryons, and to a new relation among hyperon decay S-wave amplitudes, found to be violated to approximately 40%. (auth)

**29493** TEST OF SCALING ALONE FROM Y-DISTRIBUTIONS IN HIGH ENERGY NEUTRINO (ANTINEUTRINO) REACTIONS. Korthals Altes, C. P.; Perrottet, M.; de Rafael, E. (Centre National de la Recherche Scientifique, 13 - Marseille (France). Centre de Physique Theorique). Phys. Lett., B; 57: No. 3, 260-262(7 Jul 1975).

Upper and lower bounds to y-density distributions in high energy neutrino (antineutrino) reactions are derived from the assumption of scaling of the weak structure functions alone. A discussion on the bearing of these bounds to present neutrino experiments is also given. (auth)

**29494** EFFECT OF GLUONS ON NEUTRAL-CURRENT INTERACTIONS IN DEEP INELASTIC NEUTRINO SCATTERING. Rajasekaran, G.; Roy, P. (Tata Inst. of Fundamental Research, Bombay). Pramana; 4: No. 5, 222-228(May 1975).

The contribution of neutral spin-1 gluons to the deep inelastic neutral-current process $\nu(\bar{\nu}) + N \to \nu(\bar{\nu}) +$ hadrons is worked out in the parton model. Such a contribution violates Bjorken scaling strongly. (auth)

**29495** DO DIRECT LEPTONS WITH LARGE TRANSVERSE MOMENTUM ORIGINATE FROM $\psi$ PRODUCTION. Halzen, F.; Kajantie, K. (Wisconsin Univ., Madison (USA). Dept. of Physics). Phys. Lett., B; 57: No. 4, 361-363(21 Jul 1975).

It is shown that the energy as well as the transverse momentum dependence of the yield of direct leptons in pp collisions can be obtained from the production and subsequent decay of vector mesons ($\rho,\omega,\phi$ and $\psi$). This firstly requires that the total $\psi$ yield $\sigma(pp \to \psi)$ be 0.02 $\mu$b at 70 GeV, $\sim 2\mu$b at 300 GeV, 3 to 10 $\mu$b at 1500 GeV and secondly that the transverse momentum distribution be broader than that of other hadrons, with $\langle p_T^2 \rangle \gtrsim 0.5$ (GeV/c)$^2$. (auth)

## *Strong (General)*

*Refer also to abstracts 29652 and 29921.*

**29496** (COO-3285-22) ABSTRACT ALGEBRA FOR PHYSICISTS. Zeman, J. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Physics). Jun 1975. Contract E(11-1)-3285. 25p. Dep. NTIS $4.25.

Certain recent models of composite hadrons involve concepts and theorems from abstract algebra which are unfamiliar to most theoretical physicists. The algebraic apparatus needed for an understanding of these models is summarized here. Particular emphasis is given to algebraic structures which are not assumed to be associative. (2 figures) (auth)

**29497** (JINR-P2-8983) NEW FORM OF STATISTICAL DESCRIPTION OF THE MULTIPLE HADRON PRODUCTION. Bol'f, Yu.; Dushutin, N. K.; Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 40p. (In Russian). Dep. NTIS (US Sales Only) $5.00.

Modern views to the processes of multiple hadron production were reviewed from the point of view of the Feynman analogy with gas. (auth)

**29498** (JINR-R-2-8155) MULTIPLE PRODUCTION IN A METHOD OF THE EXTENDED S-MATRIX. Sinegovskii, S. I.; Mal'tsev, V. M.; Dushutin, N. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 12p. (In Russian). INIS.

9 refs.; 1 fig.

In the extended S-matrix method an equation is constructed for multiple-particle amplitudes, and on this basis a study is made of the integral properties of multiple formation of hadrons. (tr-auth)

**29499** REGGEOMETRY. Ader, J. P. (CERN, Geneva); Peschanski, R.; Lacaze, R.; Cohen-Tannoudji, G.; Gilain, C. Nuovo Cim., A; 27A: No. 4, 385-411(21 Jul 1975).

A few general empirical laws summarizing our knowledge on two-body hadronic amplitudes are proposed. These systematics lead to a simple analytic parametrization of these amplitudes, allowing the reproduction of all the prominent features of the non-vacuum exchange data from 6 to 50 GeV/c. The obtained results, and in particular the ability of describing in a consistent way both meson and baryon exchanges, are encouraging and suggest that a framework may be found for new dynamical approaches. (23 figures, 3 tables) (auth)

**29500** PROCESSES OF GENERATION OF PARTICLES IN THE EXTENDED S-MATRIX METHOD. Dushutin, N. K.; Mal'tsev, V. M.; Sinegovskii, S. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 24: No. 1, 71-77(Jul 1975). (In Russian).

In the framework of the extended S-matrix method the equations for many-particle amplitudes are obtained, on the basis of which the integral characteristics of multiple production of hadrons are investigated. (auth)

**29501** INTRODUCTION INTO THE PHENOMENOLOGY OF THE MANY-PARTICLE GENERATION. Montvay, I. (Lorant Eotvos Univ., Budapest). Magy. Fiz. Foly.; 22: No. 6, 511-527(1974). (In Hungarian).

The most important concepts involved in the distribution of particles generated in the high energy collision of two hadrons and the phenomenology of the many-particle generation are reviewed, considering primarily the measurable features of the many-particle final states, the fundamental characteristics of the one-particle distribution, hadron fireballs and multiplicity distributions. (Review article, 21 references). (TTT)

**29502** HIGH-ENERGY DATA AND THE STRUCTURE OF THE ODD-SIGNATURE AMPLITUDE OF PION–NUCLEON SCATTERING. Bialkowski, G. (Institut de Physique Nucleaire Paris); Kang, K.; Nicolescu, B. Lett. Nuovo Cim.; 13: No. 11, 401-406 (12 Jul 1975).

New data concerning the differential cross section for pion-nucleon charge exchange and the difference between the total cross sections for $\pi^- p$ and $\pi^+ p$ in the high energy region have been reanalyzed in the framework of two models: the first with pure single rho exchange and the second with this exchange accompanied by an odd pomeron exchange. It is shown that it is difficult to explain the data by pure rho exchange. (2 Figures, 1 Table) (SDF)

**29503** HIGH-ENERGY FIXED-ANGLE SCATTERING INVOLVING A REGGEON. Scott, D. M. (Science Research Council, Chilton (UK). Rutherford Lab.). Nucl. Phys., B; 93: No. 2, 345-354(21 Jun 1975).

A high energy amplitude with single particle production investigated in a single Regge limit in which the four-particle amplitude with the reggeon as one of the external particles is evaluated in a fixed-angle, high energy limit. Constituent models suggest that asymptotically there is no azimuthal dependence, and also that the fixed-angle reggeon amplitude has power law behavior with energy. This power is discussed. (auth)

**29504** TRACES OF CHIRAL SYMMETRY ON LIGHT PLANES. Sazdjian, H.; Stern, J. (Paris-11 Univ., 91 – Orsay (France). Inst. de Physique Nucleaire). Nucl. Phys., B; 94: No. 1, 163-188 (4 Aug 1975).

The structure of theories which attempt to describe composite hadrons by means of quark field variables defined on a light plane, can be probed using the transformation properties of observables with respect to the light-plane charges. The possibly general transformation of the light-plane Hamiltonian P and of the current divergences with respect to the $[SU(3) \times SU(3)]_L$ algebra of the light-plane charges is suggested. A particular method is proposed, which allows one to test this transformation pattern via the properties of the meson spectrum. (auth)

## *Strong (Baryon No. = 0)*

**29505** (BNL-20171) SURVEY OF PARTIAL-WAVE ANALYSES ON THREE-MESON SYSTEMS. Chung, S. U. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 73p. (CONF-750242-1). Dep. NTIS $6.75.

From 3rd international meeting on fundamental physics; Sierra Nevada, Spain (10 Feb 1975).

A review is presented giving a comprehensive survey of both the mathematical formalism underlying the analysis and the experimental results of the analysis as applied to 3 pi and K pi pi systems. The purpose is not so much to give an up-to-date account of the results as to combine the survey with an exposition of relevant theoretical formulas in order to make this a reasonable self-contained review of one of the more fruitful areas of meson-resonance physics. (JFP)

**29506** (INIS-mf-1739, pp 144-157) NUMERICAL RESULTS OF THE STATISTICAL BOOTSTRAP MODEL (SBM), EXCLUSIVE

AND INCLUSIVE ANTI NN ANNIHILATIONS AT REST AND $e^+e^-$ ANNIHILATIONS. Moehring, H. J. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4–10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

It is reported on a recent application of the statistical bootstrap model (SBM) to $\bar{N}N$ and $e^+e^-$ annihilations into hadrons. The SBM was tested in detail for different cluster masses. (auth)

**29507** (JINR–P2-9042) COMMENTS ABOUT THE PROPERTIES OF NEUTRAL K MESONS PRODUCED IN INCLUSIVE PROCESSES. Lyuboshits, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The general properties of the neutral K-mesons produced in inclusive processes $a + b \rightarrow K + X$, $a + b \rightarrow K + K + X$, are discussed. The properties resulted from the strangeness conservation. The phenomenological structure of the density matrix of two neutral K-mesons was considered. (auth)

**29508** (PUC-TN-3/73) PADE APPROXIMATION OF TWO-POINT FUNCTIONS AND THE CALCULATION OF RESONANCES. Lambert, F. J. (Pontificia Universidade Catolica do Rio de Janeiro (Brazil). Instituto de Fisica). Jun 1973. 34p. INIS.

Submitted for publication in Nuclear Physics.

The application of the method of Pade approximants to two-point functions of spin 0 and spin ½ is discussed in connection with the calculation of resonances in renormalizable Lagrangian field theory. The resonances which are considered belong to the "Peierls-class": they are excited states of a particle, with the same quantum numbers as the particle except parity, corresponding to complex poles of the propagator on an unphysical Riemann sheet of the energy-plane. The diagonal Pade approximants are found to be particularly suitable for approximating the mass-function in the "modified propagator," with regard to consistency with the Källen–Lehmann representation. Contrary to perturbative approximation, they open a way for avoiding ghost-difficulties, yeilding a finite wave-renormalization constant. The analytic continuation of the propagator in the Pade approximation scheme is derived from that of the perturbation theory terms. A "resonance equation" is obtained on the real axis, the roots of which provide information on the masses of the possible resonances. The [1,1] Pade approximant is considered in the particular cases of the V-propagator in the Lee-model and the nucleon propagator in the Yukawa-model. (auth)

**29509** (RL–75-100) IS THE $A_1$ A RESONANCE. Morgan, D. (Science Research Council, Chilton (UK). Rutherford Lab.). Jun 1975. 33p. (CONF-750654-15). Dep. NTIS (US Sales Only) $4.75.

From high energy particle physics divisional conference of EPS; Palermo, Italy (23 Jun 1975).

Data on diffractive and charge exchange $3\pi$ production in the $J^P = 1^+$ state is shown to favor a resonance interpretation, although with a somewhat higher mass than the conventional $A_1$ bump. Data are fitted using a two-component model for the production amplitude. The first component comprises the Deck (Born) contribution and its re-scattering corrections; the second represents the so-called "direct-production" term. The conventional isobar approximation to unitarity is demanded; this forbids the intrusion of additional phases in the Born term, such as arise from projecting a Reggeized Deck amplitude. As a consequence, the phase of the $1^+S$ $3\pi$ production amplitude is predicted to execute a standard resonant variation with M. This carries a striking implication for the interfering "background" waves, $1^+P$, $2^-P$, $0^-S$, relative to which the $1^+S$ amplitude fails to register any appreciable phase variation in phenomenological analyses. There is no obvious objection to ascribing resonance status to these three channels, of which only one, the $0^-$, demands a new ($\pi'$) resonance. A running theme, which recurs whenever the results of phenomenological 3-body phase shift analyses are appealed to, is that dynamical features are best viewed in terms of effective matrix elements rather than partial cross sections. (auth)

**29510** ELEMENTARY SCALAR MESONS AND REGGE POLES. Cheng, H. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Mathematics); Lo, C. C. (Massachusetts. Inst. of Tech., Cambridge (USA). Dept. of Physics). Phys. Lett., B; 57: No. 2, 177-180(23 Jun 1975).

For the annihilation amplitude of $\pi^+\pi^- \rightarrow$ two vector mesons it is shown that parity conservation and rotational symmetry demand the existence of a triplet of Regge singularities crossing at t = 0. In the usual scalar-vector field theory, calculations of the leading terms of this amplitude up to the eighth order show that these singularities are moving Regge poles. Contrary to common belief, the elementary scalar meson lies on one of them. (auth)

**29511** LOCAL EXPRESSION FOR THE SPECTRAL FUNCTION OF THE MATRIX ELEMENT $(0|j_\mu^{4-i5}(x), A_\nu^3(0)|K^+(k))$. Fakirov, D. G. Bulg. J. Phys.; 11: No. 1, 30-41(1975). (In Russian).

An explicit local expression is found for the spectral function of the matrix element of the commutator $[V_\mu^{4-i5}(x), A_\nu^3(0)]$ between vacuum and K-meson state of four-momentum k. The quantity $V_\mu^{4-i5}(x)$ is defined as a combination of the fourth and the fifth unitary components of the octet of vector current densities with "lowering" operator properties in isospin space. $A_\nu^3(x)$ is the third unitary component of the octet of axial current densities. The local expression obtained in this way is integrated over $q_0$ which gives a possibility to pass to an equal-time current commutator $[V_\mu^{4-i5}(x), A_\nu^3(0)]\,\delta(x_0)$. Further one can apply Gell-Mann's current algebra in order to generate a number of sum rules, connecting definite dynamical characteristics of the set of mesons consisting of $\pi$, K, $A_1$, $K^*$ and x. (auth)

**29512** TEN-COMPONENT THEORY FOR SPIN-1 PARTICLES (ANY GYROMAGNETIC RATIO). Durand, E. (Universite Paul Sabatier, Toulouse). Nuovo Cim., B; 28B: No. 2, 415-426(11 Aug 1975).

Corben and Schwinger have introduced a parameter $\lambda$ in the tensorial equation of Proca, in order to have an arbitrary gyromagnetic ratio $g = 1 + \lambda$. In the nonrelativistic approximation, an intrinsic electric-quadrupole moment appears in their theory and the coefficient of the term with div E, in the Hamiltonian, is not correct. The matricial form of the theory suggests another formula, analogous to this of the spin-½ particle. In the nonrelativistic approximation one has then no electric-quadrupole moment and the coefficient of the term with div E is correct. One may also, in the new theory, introduce an electric-quadrupole moment chosen a priori, in the same manner as Young and Bludman did for the Corben-Schwinger theory. (auth)

**29513** STUDY OF NON-ANALYTICITY IN THE CHIRAL SYMMETRY LIMIT IN THE SU(3) SIGMA-MODEL. Khelashvili, A. A.; Khmaladze, V. Yu. (Tbilissi State Univ., USSR). Teor. Mat. Fiz.; 23: No. 3, 421-426(Jun 1975). (In Russian).

Nonanalytic behavior of propagators, vertex functions, and pseudoscalar meson octet scattering amplitudes in the chiral and low energy limits is investigated in the framework of the one-loop approximation of the perturbation theory in the SU(3) sigma-model. It is shown that the leading nonanalytic contributions in scattering amplitudes are cancelled. (auth)

**29514** DOES DYNAMICS DETERMINE THE PION-PION LOW-ENERGY CONSTANTS. Dilley, J. (Ohio Univ., Athens (USA)). Nucl. Phys., B; 93: No. 3, 479-496(28 Jul 1975).

Restrictions on low energy s-wave behavior of pion-pion scattering are studied using the N/D method and the dynamical assumption of no Castillejo-Dalitz-Dyson poles. Within the context of a model corresponding to rather well determined phenomenology, rather tight restrictions are found on the low energy constants. (auth)

**29515** CORRELATION FUNCTIONS AT BOTH ISR AND FNAL AND BOSE-EINSTEIN STATISTICS. Miyamura, O.; Biyajima, M. (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science). Phys. Lett., B; 57: No. 4, 376-378(21 Jul 1975).

A relation of $R^{\infty} - R^{ch,\circ} = R^{--}$ is obtained for two identical pions, provided that Bose-Einstein statistics is applied to them. Comparison with present data is shown. (auth)

**29516** PION FORM FACTOR AND THE QUARK MODEL FOR THE SPECTRUM OF HEAVY MESONS. Kaushal, R. S. (Delhi Univ. (India). Dept. of Physics and Astrophysics). Phys. Lett., B; 57: No. 4, 354-356(21 Jul 1975).

A Coulomb type potential between light quark-antiquark pair for separation distances $r \leq b_0$, is found to provide satisfactory values of the pion form factor in agreement with experiments, while a linear potential between heavy quark-antiquark pair for $r > b_0$, predicts the heavy meson resonances fairly well. It is found that the value of $b_0$, determined from the pion form factor data, is consistent with the slope of the linear potential used by Harrington et al. (auth)

**29517** PION-NUCLEUS INTERACTION AND THE RANGE OF $\pi$N FORCES. Huefner, J. (Heidelberg Univ. (F. R. Germany). Inst. fuer Theoretische Physik); Iachello, F. (Rijksuniversiteit Groningen (Netherlands). Kernphysisch Versneller Instituut). Nucl. Phys., A; 247: No. 3, 441-451(11 Aug 1975).

Several definitions are examined for the ranges $r_{\pi N}$ of the pion-nucleon ($\pi N$) forces and it is concluded that $0.25 \leqq r_{\pi N} \leqq 0.5$ fm. Two consequences of the finite range of the p-wave $\pi N$ interactions are investigated: the additional spatial extension of the p-wave $\pi$-nucleus optical potential and the quenching of the Lorentz-Lorenz effect. For $0.25 \leqq r_{\pi N} \leqq 0.5$ fm (i) the additional extension of the p-wave optical potential gives negligible contributions to shifts and widths in $\pi$-mesic atoms and (ii) the Lorentz-Lorenz effect is largely quenched making nuclear correlations hard to detect by mesic atoms measurements. (auth)

**29518** APPLICATION OF A MODIFIED K-MATRIX FORMALISM TO $\pi\pi$ AND $K\bar{K}$ SCATTERING. Lang, C. B. (Karlsruhe Univ. (TH) (F. R. Germany). Inst. fuer Theoretische Kernphysik). Nucl. Phys., B; 93: No. 3, 429-445(28 Jul 1975).

With the help of the recently proposed modified K-matrix formalism a coupled-channel calculation is performed for $\pi\pi$ and $K\bar{K}$. Crossed-channel influences are taken into account for $\pi\pi \to \pi\pi$ by iteration and for $\pi\pi \to K\bar{K}$ and $K\bar{K} \to K\bar{K}$ on a phenomenological basis. Direct-channel resonances are treated as coupled single-particle states. In the $\pi\pi$ channel good agreement is found with experiments below 1.2 GeV although disagreement is found with the results from linear current algebra models. The $K\bar{K}$'s wave phase shift above threshold agrees with the down solution of experiments. The predictions for the s-wave amplitudes $\pi\pi \to K\bar{K}$ below $K\bar{K}$ threshold are somewhat different from previous work; the higher partial waves are qualitatively similar to the prediction of others. (auth)

**29519** AN ANALYSIS OF THE NEW PION FORM FACTOR DATA. Kiehlmann, H. D. (Karlsruhe Univ. (TH) (F. R. Germany). Inst. fuer Theoretische Kernphysik); Schmidt, W. (Karlsruhe Univ. (TH) (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Nucl. Phys., B; 94: No. 1, 67-76(4 Aug 1975).

A form factor F(t) for the pion is constructed which is compatible with analyticity and the data in the space-like and time-like region. For the mean square pion radius $\langle r^2 \rangle = (0.46^{+0.06}_{-0.06})$ fm$^2$ is obtained. Typical errors of the extrapolated F(t) are given (e.g., $F(t = -8\ \mathrm{GeV}^2/c^2) = 0.07^{+0.04}_{-0.10}$). Assuming $F(t) \sim \beta/(-t)^{\alpha}$ at the end of the space-like data region $\beta = 0.31$, $\alpha = 0.81$ for t in GeV$^2$/c$^2$ are obtained together with the error contours of $(\alpha,\beta)$. No conclusive answer on the existence of zeroes of F(t) can be given. (auth)

## *Strong (Baryon No. = 1)*

*Refer also to abstracts 29385 and 29386.*

**29520** (EFI-59(74)) $\pi$N-ELASTIC SCATTERING AND CHARGE EXCHANGE REACTIONS IN MODIFIED QUASIEIKONAL MODEL. Eremyan, Sh. S. (Erevanskij Fizicheskij Inst. (USSR)). 1974. 36p. INIS.

22 refs.; 12 figs.; 2 tables.

Experimental data on elastic $\pi^+$p scattering and $\pi^-$p change exchange reaction are analyzed in the framework of complex angular momentum model taking into account moving cuts with "shower" factors as functions of momentum transfer. It is shown, that to describe experimental data at $/t/ > 0.7(\mathrm{GeV/c})^2$ it is necessary to introduce the t-dependence of residue function as a combination of two different exponents. For $\pi^+$p elastic scattering the model is in good agreement with experimental data for momentum transfers up to $1.5(\mathrm{GeV/c})^2$, the agreement with $\pi^-$p $\to \pi^0$n charge exchange data being up to $2(\mathrm{GeV/c})^2$. (auth)

**29521** (INIS-mf-1739, pp 140-143) MULTI-CHANNEL ANALYSIS OF THE REACTION $K^-p \to K^0\pi^-p$ AT 4.2 GeV/c. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

Amsterdam-Cern-Nijmegen Collaboration.

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4-10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

The reaction channel $K^-p \to K^0\pi^-p$ is studied at 4.2 GeV/c with the aim to trace the contributions of various subchannels and their interferences to the three-body final state. (auth)

**29522** (IS-T-687) MINIMAL REGGE MODEL FOR MESON-BARYON SCATTERING: DUALITY, SU(3) AND PHASE-MODIFIED ABSORPTIVE CUTS. Egli, S. E. (Ames Lab., Iowa (USA)). Oct 1975. Contract W-7405-eng-82. 72p. Dep. NTIS $6.75.

Thesis.

A model is presented which incorporates economically all of the modifications to simple SU(3)-symmetric dual Regge pole theory which are required by existing data on $0^-\frac{1}{2}^+$ yields $0^-\frac{1}{2}^+$ processes. The basic assumptions are no-exotics duality, minimally broken SU(3) symmetry, and absorptive Regge cuts phase-modified by the Ringland prescription. First it is described qualitatively how these assumptions suffice for the description of all measured reactions, and then the results of a detailed fit to 1987 data points are presented for 18 different reactions. (auth)

**29523** (JINR-1-8035) COMPARISON OF MULTIPERIPHERAL THEORY WITH EXPERIMENT WITH RESPECT TO $\pi^-$p INTERACTIONS AT P = 40 GeV/c. Volkov, E. I.; Kanarek, T. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 18p. (In Russian). INIS.

10 refs.; 13 figs.; 2 tables.

Experimental data on the $\pi^-$p interaction at P = 40 Gev/c, obtained in a 2-meter propane chamber, are compared with a multiperipheral model based on the Bethe-Salpeter equation. The average characteristics and single particle distributions according to the different variables agreed well with the experimental data. The disadvantage of using the parameters selected and a possible path of its elimination are shown. (tr-auth)

**29524** (JINR-1-8251) SYSTEM OF DATA PROCESSING PROGRAMS FOR THE $\pi^-$p ELASTIC SCATTERING AT 40 AND 50 GeV. Nurushev, S. B.; Solov'ev, L. F.; Dalli, E.; Driki, D.; Tompkins, J.; Shepard, P.; Adylov, G. T.; Aliev, F. K.; Vodop'yanov, A. S.; Ioan, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 12p. (In Russian). INIS.

4 refs.; 3 figs.

A program is described for regenerating trajectories and extraction of the events of $\pi^-$p elastic scattering at energies of 40 and 50 GeV. (tr-auth)

**29525** (RL-75-071) NUCLEON EXCHANGE: A SIMPLE DESCRIPTION. Gula, A.; Pennington, M. R. (Science Research Council, Chilton (UK). Rutherford Lab.). May 1975. 28p. Dep. NTIS (US Sales Only) $4.50.

It is shown that the high energy behaviour of exclusive and inclusive processes dominated by nucleon exchange can be described by simple forms suggested by dual amplitudes. The energy, momentum transfer and mass dependences of the differential cross-sections are reproduced. The value of the triple-Regge NNf coupling is obtained. The role of MacDowell partners and of exotic exchanges are discussed. (auth)

**29526** (RL-75-101) GEOMETRICAL SCALING IN phiN SCATTERING. Barger, V.; Phillips, R. J. N. (Wisconsin Univ., Madison (USA). Dept. of Physics; Science Research Council, Chilton (UK). Rutherford Lab.). Jun 1975. Contract E(11-1)-881. 11p. Dep. NTIS $4.00.

Geometrical scaling has been proposed for the Pomeron term in elastic scattering. An investigation is made of phi-N scattering that is expected to be Pomeron-dominated even at quite low energies, and it is found that present data are quite consistent with geometrical scaling down to 4 GeV and possibly even to 2 GeV. (auth)

**29527** ISOBAR MODEL ANALYSIS OF THE REACTIONS K-N $\alpha$ $K^-\pi^-p$ AND $K^-n$ $\alpha$ ANTI $K^0\pi^-n$ IN THE CENTER-OF-MASS ENERGY REGION 1.9 TO 2.2 GEV. Corden, M. J.; Cox, G. F.; Dartnell, A.; Kenyon, I. R.; O'Neale, S. W.; Sumorok, K.C.T.O.; Watkins, P. M. (Birmingham Univ. (UK). Dept. of Physics). Nucl. Phys., B; 92: No. 3, 365-390(7 Jul 1975).

A program has been developed to perform a general isobar model partial-wave analysis of reactions of the type baryon + meson $\to$ baryon + meson + meson. Using this program energy-independent fits to the reactions $K^-n \to \bar{K}^0\pi^-n$ and $K^-n \to K^-\pi^-p$ have determined the most important partial waves for the quasi-two-body final states $\bar{K}^*(890)N$, $K\Delta(1236)$, $\Lambda(1520)\pi$ and $\Lambda(1815)\pi$ in the centre-of-mass energy range 1.9 to 2.2 GeV. The results show clear evidence for $K\Delta(1236)$ and $\Lambda(1815)\pi$ decay modes of the $\Sigma(2030)$, but the branching fraction for the decay of $\Sigma(2030)$ to $\Lambda(1520)\pi$ is found to be only 0.06. The complexity of the results for the $\bar{K}^*(890)N$ partial waves makes it unclear whether there is also a $\bar{K}^*(890)N$ decay of the $\Sigma(2030)$. (auth)

**29528** EVALUATION OF THE PION-NUCLEON SIGMA TERM. Chao, Y. A.; Cutkosky, R. E. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Physics); Kelly, R. L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Alcock, J. W. (Bristol Univ. (UK)). Phys. Lett., B; 57: No. 2, 150-154(23 Jun 1975).

The sigma-commutator term has been evaluated for pi N scattering by using a new method to extrapolate the $C^+$ amplitude below threshold. Reproducing kernel techniques are used to extrapolate

along hyperbolic curves whose lower branches lie within the physical region for energies above the elastic threshold. The value obtained is sigma/sup pi pi/sub NN/ equals 57 +- 12 MeV. (auth)

**29529** P-ODD EFFECTS AT INTERACTION OF HIGH-ENERGY HADRONS. Kopeliovich, V. B.; Frankfurt, L. L. (Leningrad Inst. of Nuclear Physics). Yadern. Fiz.; 21: No. 4, 799-804(Apr 1975). (In Russian).

The P-odd effects in resonance production high-energy reactions are considered, that arise at interference between the strong amplitude and the weak W-boson exchange amplitude. The P-odd asymmetry of the secondary particle emission in the isobar production reactions, e.g., $\pi^+p \to \pi^0\Delta^{++} \to \pi^0\pi^+p$, does not depend on spins of the involved nucleons. Vector meson production reactions are considered, as well as the $\Lambda$-hyperon polarization in the reactions like $\pi^-p \to K^{0*}\Lambda$, $K^-p \to \varphi\Lambda$. The typical magnitude of the effects is about $10^{-4}$ at $E_{lab} \approx 10^3$ GeV. (auth)

**29530** PARTIAL-WAVE ANALYSIS OF THE REACTION piN YIELDS pipiN IN THE CM ENERGY RANGE 1300 TO 2000 MeV. Herndon, D. J. (Univ. of California, Berkeley); Longacre, R.; Miller, L. R.; Rosenfeld, A. H.; Smadja, G.; Soeding, P.; Cashmore, R. J.; Leith, D. W. G. S. Phys. Rev., D; 11: No. 11, 3183-3213(1 Jun 1975).

A partial-wave analysis of the reaction pi N yields pipi N was carried out in the energy region 1300 to 2000 MeV. Two continuous solutions were found; they are very similar in regions where data exist, but differ in the continuation of amplitudes through a gap between low and high energy data. The second solution ("B") gives a much better fit to the data. These new partial-wave amplitudes provide important information on the inelastic couplings of the nucleon resonances to the N rho, N epsilon, and DELTA pi channels. A new resonance, $D_{13}(1700)$, long predicted by the quark model, was observed coupling to two inelastic channels--epsilon N and DELTA pi, and the existence of a $P_{13}(1700)$ state is corroborated. The preferred solution indicates a second new resonance, $P_{33}(1700)$, coupled strongly to the DELTA pi channel. (auth)

**29531** ENERGY DEPENDENCE OF THE SLOPE OF THE DIFFRACTION MAXIMUM FOR $\pi^-$p-ELASTIC SCATTERING. Devonsky, P. A. (Higher Chemical-Mechanical Inst., Sofia). Bulg. J. Phys.; 11: No. 1, 9-12(1975). (In Russian).

Research is carried on the energy dependence of the slope of the diffraction maximum for $\pi^-$p-elastic scattering. The diffraction cross section is approximated with an exponent in the interval $0.06 \lesssim |t| \lesssim 0.4$ (Gev/c)$^2$. There was established a shrinkage of the diffraction maximum with increase of energy within the range $6 \leq s \leq 76$ GeV$^2$. (auth)

**29532** POTENTIAL SHAPE OF THE $\pi^+$p INTERACTION AT 98 MeV. Pelosi, V.; Bombana, M. (Univ., Milan). Lett. Nuovo Cim.; 13: No. 10, 353-356(5 Jul 1975).

Construction of a potential for the inverse problem of $\pi^+$p scattering for a fixed energy is discussed in terms of a general Newton-Sabatier inversion of the Schroedinger equation. The method has been applied to $\pi^+$p elastic phase shifts at 98 MeV. As the equation does not allow for half integer spins, the sets $J = l + \frac{1}{2}$ and $J = l - \frac{1}{2}$ have been considered separately, leading to partial parallel and partial antiparallel potentials. It is concluded that the method is practicable for unfolding meson-hadron potentials in the wholly elastic range. (SDF)

**29533** A COMPARISON OF REACTIONS OF THE TYPE PB $\to V^0\Delta$. Owens, J. F.; Eisner, R. L. (Case Western Reserve Univ., Cleveland, Ohio (USA)); Chung, S. U.; Protopopescu, S. D. (Brookhaven National Lab., Upton, N. Y. (USA)). Nucl. Phys., B; 94: No. 1, 77-99(4 Aug 1975).

A comparison of the reactions $\pi^+p \to \rho^0\Delta^{++}$, $\pi^+p \to \omega\Delta^{++}$, and $K^+p \to K^{*0}\Delta^{++}$ is made using data near 7 GeV/c. Particular attention is paid to the question of relative normalization for each of the reactions. Using an SU(3) sum rule, predictions are made for the reaction $K^-n \to K^{*0}\Delta^-$. A phenomenological model is presented which is based on Regge pole exchange modified by Regge cuts in those amplitudes with zero net helicity. Excellent fits to the $\rho^0\Delta^{++}$ and $\omega\Delta^{++}$ observables are obtained. The resulting amplitudes are then used to predict the observables in $K^+p \to K^{*0}\Delta^{++}$. (auth)

**29534** GEOMETRICAL DESCRIPTION OF BINARY REACTIONS AND LARGE $P_\perp$ PHENOMENA. Elvekjaer, F. (European Organization for Nuclear Research, Geneva (Switzerland)); Petersen, J. L. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Nucl. Phys., B; 94: No. 1, 100-114(4 Aug 1975).

The consequences of defining the impact parameter as being the variable conjugate to transverse relative c.m. momentum, $p_\perp$ are studied. This coincides with a proposal originally made by Chang and Raman. The dynamical information carried by these are intimately connected to the behavior of 90° scattering. In particular, impact parameter dynamics is a priori qualitatively different from direct channel angular momentum dynamics. A phenomenological study of elastic $\pi^\pm$p and pp data at fixed values of longitudinal momentum, $p_\parallel$, leads to a generalized geometrical scaling hypothesis. In contrast with the power behavior predicted by parton models, the data suggest exponential behavior of the scaling amplitudes at fixed $p_\parallel$ of the type $e^{Rp_\perp}$ with $R \simeq 1$ fm. Correspondingly these amplitudes are described by a pair of complex conjugate singularities on the imaginary axis in the impact parameter plane. (auth)

**29535** ENERGY-INDEPENDENT PARTIAL-WAVE ANALYSIS OF $\bar{K}N \to \Lambda\pi$ BETWEEN 1540 AND 2150 MeV. Baillon, P. (European Organization for Nuclear Research, Geneva (Switzerland)); Litchfield, P. J. (Science Research Council, Chilton (UK). Rutherford Lab.). Nucl. Phys., B; 94: No. 1, 39-66(4 Aug 1975).

An exhaustive partial-wave analysis of the reaction $\bar{K}N \to \Lambda\pi$ was carried out on a compilation of all available data using two separate semi-energy-independent methods. Particular attention was given to finding all ambiguous solutions. Two possible solutions are found consistent with the physical assumptions imposed. Two parameters of the resonances appearing in the two solutions are given. (auth)

## *Strong (Baryon No. ≥ 2)*

*Refer also to abstract 29367.*

**29536** (INIS-mf-1739, pp 106-121) CAN EXCLUSIVE REACTIONS BE ANALYZED IN TERMS OF TRIPLE REGGE AMPLITUDES. Antich, P.; Calligarich, E.; Cecchet, G.; Dolfini, R.; Ratti, S. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4-10 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

The application is shown of an inclusive formula to the reaction $pp \to pp\pi^+\pi^-$ analyzing this reaction at 10 different momenta from 4 to 25 GeV/c on a world data summary tape. Parametrizing the data as if the reaction was inclusive the slope of the t' distribution is s independent and exponential in $(M^2/s)$; for large $M^2$ the mass distributions go as $(1/M^2)^{-2.4}$ independent of s, i.e., an exclusive reaction displays regularities typical of inclusive reactions. (auth)

**29537** (INIS-mf-1739, pp 161-185) MULTICLUSTER PRODUCTION THEORY AND ITS COMPARISON WITH $pp^-$ EXPERIMENT AT 70 GeV. Chernavskii, D. S.; Dremin, I. M.; Dunaevskii, A. M.; Royzen, I. I.; Volkov, E. I. 1974.

From 5th international symposium on many particle hadrodynamics; Eisenach; Leipzig, German Democratic Republic (4 Jun 1974).

In proceedings of the 5th international symposium on many particle hadrodynamics, Eisenach and Leipzig, GDR, June 4-10, 1974. (Physikalische Gesellschaft der DDR, Berlin (German Democratic Republic); Karl-Marx-Universitaet, Leipzig (German Democratic Republic); Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik).

The main results are briefly reviewed of multicluster production theory. It is shown that they lead to a good combined description both of properties of Regge trajectories and of inelastic processes at 70 GeV. (auth)

**29538** (JINR-P2-9088) POWER AUTOMODEL ASYMPTOTICS OF THE NUCLEON-NUCLEON SCATTERING AT LARGE ANGLES. Goloskokov, S. V.; Kuleshov, S. P.; Matveev, V. A.; Smondyrev, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1975. 15p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A study is made of the power automodel asymptotics of the nucleon-nucleon scattering at large angles in the framework of the quasipotential Logunov-Tavkhelidze approach. For analytical quasipotentials, satisfying the $\gamma_5$ invariance condition, there was found the angle dependence of the differential cross section. These results are compared with the experimental data. (auth)

**29539** (RL-75-085) LONG-RANGE CORRELATIONS AS A PHENOMENOLOGICAL PROBE OF NON-SCALING BEHAVIOUR. Kwiecinski, J.; Roberts, R. G. (Science Research Council, Chilton (UK). Rutherford Lab.). May 1975. 15p. Dep. NTIS (US Sales Only) $4.00.

Since pure scaling terms give no correlations in the double fragmentation region, then the magnitude of such a correlation provides a sensitive measure of the non-scaling terms. The normalised correlation R for $pp \rightarrow pp + X$ at one ISR energy will allow one to distinguish the various triple-Regge analyses of $pp \rightarrow pX$. The correlations at lower energies for non-diffractive processes are also discussed. (auth)

**29540** LEPTON PAIR PRODUCTION IN HADRON–HADRON COLLISIONS FROM AN EXPLICIT PARTON MODEL. Altarelli, G.; Cabibbo, N.; Petronzio, R. (Rome Univ. (Italy). Istituto di Fisica); Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Nucl. Phys., B; 92: No. 3, 413-426(7 Jul 1975).

Lepton pair production in hadron-hadron scattering is studied in the parton model according to the Drell-Yan approach. Parton distribution functions for nucleons and anti-nucleons are used which were previously obtained in a model of the nucleon as a bound state of three constituent colored quarks. Each constituent quark has itself a structure in terms of partons. The same model is extended to pseudoscalar mesons. Quantitative predictions are thus obtained for lepton pair production in $P, \bar{P}$, $\pi^{\pm}$, $K^{\pm}$ scattering off nucleon targets. (auth)

**29541** AN ANOMALY IN THE REACTION $n + p \rightarrow D + 2\gamma$. Blomqvist, J.; Ericson, T. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 57: No. 2, 117-122(23 Jun 1975).

The recently observed doubly radiative n-p capture is analyzed. It is shown that the experimental result is impossible to explain within the present theoretical framework. (auth)

**29542** DESCRIPTION OF THE PROCESSES $np \rightarrow pn$ AND ANTI $p-p \rightarrow$ ANTI $n-n$ IN THE THEORY OF COMPLEX ANGULAR MOMENTA. Boreskov, K. G.; Sukhorukov, S. T.; Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 21: No. 4, 825-835(Apr 1975). (In Russian).

The features of the nucleon charge exchange reactions $np \rightarrow pn$, $\bar{p}p \rightarrow \bar{n}n$ at high energy are studied in the theory of complex angular momenta with branch points. The available experimental data are described and predictions are made concerning the features of the reactions under consideration at higher energies. (7 figures, 3 tables) (auth)

**29543** INVESTIGATION OF INCLUSIVE REACTIONS $pp \rightarrow \pi^+ +$ ANYTHING. Takibaev, Zh. S.; Boos, E. G.; Sharapov, K. V.; Mukhordova, T. I. (Inst. of High Energy Physics, Alma-Ata, USSR). Yadern. Fiz.; 21: No. 4, 841-849(Apr 1975). (In Russian).

The experimental data are compared with various theoretical and model conceptions applied to describe the one-particle inclusive processes in a wide range of the incident proton momenta (12 to 1500 GeV/c). It is shown that the considered modifications of the thermodynamical models are in essential disagreement with the experiment. The measured values of the structure function in the energy range 10 to $10^3$ GeV agree reasonably with predictions of the Regge-type models and of a simple phenomenological model based on use of the quantal uncertainty relation. (8 figures) (auth)

**29544** POLE MODEL OF THE SCATTERING AMPLITUDE WITH A HIGHEST POSSIBLE GROWTH OF THE CROSS SECTION. Mur, V. D.; Popov, V. S. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 21: No. 4, 868-877(Apr 1975). (In Russian).

According to the known Froissart inequality, the total cross section $\sigma_t$ at $s \rightarrow \infty$ cannot grow more rapidly than $\ln^2 s$. The pole models of partial amplitudes of the cross channel leading to the highest possible growth $\sigma_t \sim \ln^2 s$ and consistent with the unitarity condition in the s channel are considered. It is shown that in the region of the parameter $\rho \sim \ln s$ an automodel regime is being settled, i.e., the partial amplitudes of the s channel asymptotically depend only upon the ratio $\rho/\ln s$. General features of the amplitudes as well as the cases $\sigma_t \sim \ln s$ are briefly discussed. (2 figures) (auth)

**29545** CROSS SECTIONS OF GENERATION OF QUASINUCLEAR MESONS IN FAST ANTIPROTON BEAMS. Dal'karov, O. D.; Markushin, V. E. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 21: No. 4, 878-882(Apr 1975). (In Russian).

Differential cross sections are calculated for production of quasinuclear mesons in the substitution reaction $d(\bar{p}, N)X$ induced by the antiprotons with the momentum $k = 1$ GeV/c. (2 figures) (auth)

**29546** TEST OF THE UNITARY POLE APPROXIMATION TO THE MALFLIET-TJON POTENTIAL ELASTIC NEUTRON-DEUTERON SCATTERING. Ziegelmann, H. (Tuebingen Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Z. Naturforsch., a; 30: No. 4, 434-436(Apr 1975).

3 figs.; 1 tab.; 16 refs.

The quality of the unitary pole approximation to the soft-core Malfliet-Tjon potential is demonstrated for elastic neutron-deuteron scattering above breakup threshold. (auth)

**29547** MULTIPLE PION PRODUCTION ASSOCIATED WITH ANTI $K^0$ IN THE 12.6 GeV/c $K^-p$ REACTION. Okabe, H. (Osaka City Univ.). Nuovo Cim., A; 28A: No. 1, 75-88(1 Jul 1975).

The multiple pion production with anti $K^*$ in the 12.6 GeV/c $K^-p$ reaction is studied and it is shown that in this reaction not only the protons behave as the leading particles, but also the K-mesons do. Moreover, if the contribution of anti-$K^*(890)$ and/or $\Delta(1236)$ is taken into account, it is found that the residual pion production is isotropic in the rest system of the missing mass without anti-$K^*$ or anti-$K^*(890)$ and/or proton or $\Delta(1236)$. In addition, the one-fireball model parametrized by the double-Regge formula is calculated and it is shown that this model reproduces well the momentum distributions of the pions in the centre-of-mass system of $K^-$ and proton. (12 figures, 1 table) (auth)

**29548** GEOMETRIC SCALING IN HIGH-ENERGY ELASTIC AND INELASTIC PP COLLISIONS. Kamal, A. N.; Torgerson, R. (Univ. of Alberta, Edmonton). Lett. Nuovo Cim.; 13: No. 15, 591-596(9 Aug 1975).

A geometric scaling model is applied to high energy scattering of protons by protons. Information on elastic scattering is related to particle production through the impact parameter profile function. Calculated reduced moments are compared with experiment. (SDF)

**29549** NONRELATIVISTIC SINGULARITIES OF THE GRAPH "SQUARE WITH A DIAGONAL." Blokhintsev, L. D.; Safronov, A. N.; Schwarz, I. A. (Moscow State Univ.). Teor. Mat. Fiz.; 24: No. 1, 90-99(Jul 1975). (In Russian).

Nonrelativistic singularities of the Feynman graph "square with a diagonal" with respect to the variable $z = \cos\theta$ ($\theta$ being the scattering angle) were investigated. The determination of the location of these singularities is reduced to the solution of an algebraic equation of the seventh degree. In some particular cases, including the practically important case of elastic scattering by a deuteron, the singularities can be found analytically. Considered as examples are the singularities on the physical sheet of z-plane for the graphs corresponding to the elastic Nd-, $\pi$d-, N$\alpha$-, and $\pi\alpha$-scattering. (auth)

**29550** EXCHANGE CURRENT EFFECTS IN PION DOUBLE CHARGE EXCHANGE FROM $^4$He. Germond, J. F.; Wilkin, C. (University Coll. of Science and Tech., London). Lett. Nuovo Cim.; 13: No. 16, 605-609(16 Aug 1975).

Before pion double charge exchange can become a useful probe of nuclear structure, its dominant reaction mechanism must be isolated. It is proposed that the most important mechanism could involve pion scattering from the pion cloud surrounding the nucleus, i.e., involve exchange currents. This hypothesis is tested in the case of $^4$He, where reasonable data exist at 485 MeV and nuclear structure effects, multiple scattering, and other complications are minimal. (3 figures) (SDF)

**29551** EVIDENCE AGAINST THE EXISTENCE OF A LOW MASS SCALAR BOSON FROM NEUTRON–NUCLEUS SCATTERING. Barbieri, R.; Ericson, T. E. O. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 57: No. 3, 270-272(7 Jul 1975).

The existence of a weakly-coupled scalar boson, recently proposed to explain the apparent discrepancy in X-rays from muonic atoms is shown to be inconsistent with the angular distribution measurements in low energy neutron-nucleus scattering. Other negative evidence from various different physical situations is also briefly reviewed. (auth)

**29552** HOW WELL CAN HIGH-ENERGY PROTON SCATTERING DETERMINE THE NUCLEAR-MATTER DENSITY. Lombard, R. J. (Inst. of Nuclear Physics, Orsay, France); Wilkin, C. Lett. Nuovo Cim.; 13: No. 12, 463-467(19 Jul 1975).

The problem of measuring elastic proton-proton scattering out to large values of momentum transfer is discussed using a simplified Glauber theory to describe the scattering process. The type of information obtainable is studied with emphasis on the nuclear matter density. (2 figures) (SDF)

**29553** EQUIVALENT LOCAL NUCLEON–NUCLEON $^1S_0$ AND $^1D_2$ POTENTIALS DERIVED FROM THE LIVERMORE PHASE SHIFTS. Kermode, M. W.; McKerrell, A. (Univ. of Liverpool). J. Phys., G (London); 1: No. 6, 623-637(1 Aug 1975).

Sets of equivalent local nucleon-nucleon potentials which reproduce the Livermore $^1S_0$ and $^1D_2$ phase shifts almost exactly are introduced. The shape of the $^1S_0$ p-p potentials resolves the discrepancy between previous potential and phase shift descrip-

tions of the interaction but raises further questions about the accuracy of the phase shifts and the nonlocality of the interaction. The $^1D_2$ potential is found to have more flexibility than hitherto suggested. The result for the $^1S_0$ n-p potential is of interest in that the constrained set of phase shifts produces a more regular shape than the unconstrained set. (auth)

**29554** NONLOCAL $^1S_0$ p–p POTENTIALS AND THE NEUTRON–NEUTRON SCATTERING l = LENGTH. Kermode, M. W.; McKerrell, A. (Univ. of Liverpool). J. Phys., G (London); 1: No. 6, L40–L42(1 Aug 1975).

Potentials with both local and nonlocal parts were found which reproduce the experimental $^1S_0$ p-p phase shifts to a high degree of accuracy and which give values for the neutron-neutron scattering length $a_{nn}$ between −17.1 fm and −16.1 fm. Furthermore, the knoll in the local potential is greatly affected by the strength of the nonlocal term and almost completely disappears when $a_{nn}$ is equal to −16.1 fm. (auth)

**29555** SPATIAL TWO-COMPONENT STRUCTURE OF HADRONS IN THE HYDRODYNAMIC MODEL. Sohlo, S.; Wilk, G. (Univ. of Helsinki). Lett. Nuovo Cim.; 13: No. 10, 375-379(5 Jul 1975).

Approximate analytical solutions of hydrodynamic model equations are investigated in detail in one, two, and three dimensions and for all values of the speed of sound. The results are applied to the rapidity and transverse momentum distributions in pp collisions and to the momentum distribution in $e^+e^-$ annihilation to hadrons. The same equation of state for the hadronic matter is found to describe $e^+e^-$ annihilation and pp large transverse momentum distributions but a different one is needed to describe small transverse momentum distributions in pp interactions, suggesting a two-component structure of hadrons in space. (SDF)

**29556** INVESTIGATION OF A QUASI-BOUND T = 2(NΔ) STATE WITH INCREASED LIFETIME OF THE Δ. Arenhoevel, H. (Mainz Univ. (F. R. Germany). Inst. fuer Kernphysik). Nucl. Phys., A; 247: No. 3, 473-494(11 Aug 1975).

The (NΔ) system has been investigated to see whether a quasi-bound state exists for which the lifetime of the Δ is considerably increased. The (NΔ) interaction using π- and ρ-meson exchange has been studied for various approximations. In particular, the Δ-nucleon mass difference and the Δ-width have been included leading to a complex (NΔ) potential. One finds that the ($T = 2$, $J^P = 2^+$) state is bound with a binding energy of 10 to 40 MeV depending on the type of potential used and on the regularization range. Furthermore, for this state the decay width of the Δ is strongly reduced by binding effects and the Pauli principle. The reduction amounts to a factor of three to five. (auth)

**29557** LONG-RANGE CORRELATIONS AS A PHENOMENOLOGICAL PROBE OF NON-SCALING BEHAVIOUR. Kwiecinski, J.; Roberts, R. G. (Science Research Council, Chilton (UK). Rutherford Lab.). Phys. Lett., B; 57: No. 4, 349-353(21 Jul 1975).

Since pure scaling terms give no correlations in the double fragmentation region, then the magnitude of such a correlation provides a sensitive measure of the nonscaling terms. The normalized correlation R for $pp \to pp + X$ at one ISR energy will allow one to distinguish the various triple-Regge analyses of $pp \to pX$. The correlations at lower energies for nondiffractive processes are also discussed. (auth)

# Particle Invariance Principles and Symmetries

## General

*Refer also to abstracts 30035 and 30036.*

**29558** (JINR-R-4-8067) ON THE THEORY AND CLASSIFICATION OF COLOR SYMMETRY GROUPS. Part 1. P-symmetry. Koptsik, V. A.; Kotsev, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. (In Russian). INIS.

20 refs.; 3 tables.

A classification of color symmetry groups of the three basic types – P, Q, and W – is presented. The theory of P symmetry is discussed, and a complete list of groups of this type, isomorphous with point groups, is given. (tr-auth)

**29559** (JINR-R-4-8068) ON THE THEORY AND CLASSIFICATION OF COLOR SYMMETRY GROUPS. Part 2. W-symmetry. Koptsik, V. A.; Kotsev, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. (In Russian). INIS.

20 refs.; 5 figs.; 1 table.

The theoretical group bases of color symmetry groups of a new type (W) symmetry are presented. These groups are subgroups of $P_gG$ interlacings. A theory of groups of W symmetry with noninvariant classic subgroups is developed, the existence of two classes of such groups is shown, and a complete interlacing of groups of this type, isomorphous with point groups, is presented. (tr-auth)

**29560** DYNAMICAL SYMMETRY BREAKING, RENORMALIZABILITY, AND PHENOMENOLOGICAL LAGRANGIANS. Lemmon, J.; Mahanthappa, K. T. (Univ. of Colorado, Boulder). Nuovo Cim., 27A: No. 4, 349-359(21 Jul 1975).

The dynamical symmetry breaking of a chiral $U_l \times U_l$ invariant model is considered. Assuming the existence of a massless pseudoscalar bound state, which decouples, and a massive scalar bound state, sufficient conditions of renormalizability of the symmetry-broken theory using phenomenological Lagrangians are deduced. Comments are offered on the feasibility of dealing with these conditions. (auth)

**29561** $\gamma_5$ TRANSFORMATIONS AND SUPERSYMMETRY. Dondi, P. H. (Univ., Karlsruhe, Ger.). J. Phys., A (London); 8: No. 8, 1310-1312(Aug 1975).

The algebra of supersymmetry transformations including a $\gamma_5$ transformation but not the full conformal group is studied and shown to imply strong restrictions on invariant actions. The connection to the R invariance of Fayet (Nucl. Phys.; B90: 104 (1974)) is made obvious. (auth)

**29562** GENERALIZATION TO SU4 OF THE OKUBO MASS FORMULA. Macfarlane, A. J. (Cambridge Univ., Eng.). J. Phys., G (London); 1: No. 6, 601-605(1 Aug 1975).

Some properties of SU4 representations are studied with a view to discussing mass formulas. Taking $H_1 = H_0 + H_2$, where $H_0$ is SU4-scalar and $H_2$ behaves under SU4 like its SU3-scalar generator, a mass formula is derived for the mass splittings of a general SU4 multiplet into SU3 multiplets. Simplification of this for certain important subclasses of SU4 representations is noted. (auth)

## Applications (Electromagnetic and Weak)

**29563** (JINR-P2-9053) ALGEBRA OF GELL–MANN'S MATRICES FOR SU(3) GROUP. Lukach, I.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1975. 30p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

The algebra of SU(3) group containing no algebra of SU(2) group is considered. Such an algebra is very interesting because of the possibility of continuous transition to any subalgebra from the three subalgebras of SU(3) group. This algebra is isomorphous to the algebra of Gell–Mann's matrices and is connected with the motion group of the root space. Such an algebra has a physical interpretation too, since it allows one to join strong and electromagnetic interactions in the framework of the SU(3) symmetry in a natural way. (auth)

**29564** NONLEPTONIC PROCESSES AND CHIRAL $SU_3 \times SU_3$ SYMMETRY. Gutierrez, J.; Tiemblo, A. (Instituto Rocasolano, Madrid). Nuovo Cim., 27A: No. 4, 373-384(21 Jul 1975).

A systematic analysis of the nonleptonic hyperon decays in the chiral $SU_3 \times SU_3$ symmetry scheme is considered. This analysis enables a very good prediction for the P-wave amplitudes in terms of λ. The latter characterizes the $SU_3$ breaking. The parity-conserving amplitudes, obtained from a current-current interaction, are completed by contributions derived from a phenomenological Lagrangian for baryons and mesons. Thus, a nonvanishing value for $B_{\Sigma^+}$, which is proportional to the vacuum expectation value of the strange scalar meson $\sigma_{K^0}$, is obtained. By taking $B_{\Sigma^-} = 0$, which is in good agreement with experimental data, $(\sigma_{K^0})_0$ results to be a function of the Fermi constant and Cabibbo's angle. (1 table) (auth)

# Scattering Theory

*Refer also to abstracts 29292, 29327, 29503, and 30061.*

**29565** (JINR-R-2-8090) THREE-REGGEON RESCATTERING IN $\phi^3$-THEORY. Gershkevich, M. V.; Efremov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 14p. (In Russian). INIS.

13 refs.; 3 figs.

Using a diagram simulating a 3-Reggeon volume in $\phi^3$ theory, it was shown that rescattering of Reggeons gives a cut at a particular point, the defining equation for which is shown. The data for this point are easily generalized for other points. (tr-auth)

**29566** (ORO-233) PERIPHERAL PEAKING AND SHRINKAGE PHENOMENON IN S-CHANNEL BASED ON STATISTICAL BOOTSTRAP MODEL WITH SPIN. Chiu, C. B. (Texas Univ., Austin

(USA). Center for Particle Theory). Sep 1975. Contract AT(40-1)3992. 17p. Dep. NTIS $4.00.

It was observed that the spectrum of the statistical bootstrap model with spin can indeed give rise to peripheral peak in two-body scattering. This further confirms the conclusion of an earlier work by Kogitz et al. One also presents a new refined solution to the bootstrap model, which provides shrinkage phenomenon for peripheral peaks. (auth)

**29567** (RL-75-108) VACUUM POLARISATION FOR FINITE RANGE POTENTIALS, USING GREEN'S FUNCTIONS. Smith, P. F.; Lewin, J. D. (Science Research Council, Chilton (UK). Rutherford Lab.). Jun 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

The study of vacuum polarization in strong finite range potentials is continued. The summation giving the first order (unrenormalised) induced charge distribution for a spherical potential well is re-expressed as a contour integral, using the Green's function technique developed by Wichmann and Kroll for the Coulomb potential. Computations for specific cases confirm results previously obtained by the summation technique. It is shown how the method can be extended to any multi-step or continuous nonsingular potential function of finite range. (auth)

**29568** (RL-75-109) GEOMETRICAL SCALING AND THE REAL PART OF THE POMERON. Dias de Deus, J. (Science Research Council, Chilton (UK). Rutherford Lab.). Jul 1975. 8p. (CONF-750649-2). Dep. NTIS (US Sales Only) $4.00.

From symposium on hadron physics at high energies; Liblice, Czechoslovakia (16 Jun 1975).

Consequences of the hypothesis of geometrical scaling of the inelastic overlap function applied to the Pomeron amplitude are discussed. From analiticity and crossing symmetry some predictions are given for the asymptotic real part of the Pomeron. (auth)

**29569** (TAUP-442-74) DUALITY IN THE TRIPLE REGGE REGION. Horn, D.; Moshe, M. (Tel Aviv Univ. (Israel). Dept. of Physics and Astronomy). [nd]. 13p. INIS.

5 figs.

We demonstrate how a consistent dual representation of the triple Regge region can be achieved in the limit $s \to \infty$. In particular we consider pion production in the baryon fragmentation region. One of the channels dual to Regge exchange is diffractive production of high mass resonances. It turns out that at finite s some of the important production mechanisms are forbidden kinematically. This may explain the apparent low intercepts in RRP fits to data at $s = 40$ GeV$^2$ and leads to the expectation that higher intercepts will be obtained in the NAL and ISR energy ranges. (auth)

**29570** MULTIPLICITY DISTRIBUTION IN A UNITARY UNCORRELATED CLUSTER MODEL. de Groot, E. H. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 57: No. 2, 159-160(23 Jun 1975).

A formula for the KNO multiplicity distribution function is proposed, derived from a unitary uncorrelated cluster model. (auth)

**29571** ASYMPTOTIC BEHAVIOR OF ELEMENTARY FERMION FORM FACTORS IN NON-ABELIAN GAUGE THEORIES. Carazzone, J.; Poggio, E. C.; Quinn, H. R. (Harvard Univ., Cambridge, Mass. (USA). Lyman Lab. of Physics). Phys. Lett., B; 57: No. 2, 161-164(23 Jun 1975).

The leading contributions to the fermion-fermion-vector-meson form factor with non-Abelian gluons exchanged between the fermions in the region $-q^2 > p^2$, $p'^2 > m^2$, $q^2$ space like are calculated. For either incoming photon or gluon a result is obtained which shows that these contributions do not add to give a damped exponential of the form $\exp[-A \ln^2(-q^2)]$. This letter outlines the main features of the results. (auth)

**29572** EQUATION FOR THE IMAGINARY PART OF THE SCATTERING AMPLITUDE IN THE LADDER APPROXIMATION. Arbuzov, B. A.; Rchev, V. E. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 21: No. 4, 883-889(Apr 1975). (In Russian).

The equation for the imaginary part of the forward scattering amplitude is written in the ladder approximation. The exact solution of the equation is obtained for $\lambda\varphi^3$-theory. It is shown that for an arbitrary value of the coupling constant the total cross section has a power asymptotics, the scaling is valid, and the mean multiplicity increases logarithmically. (auth)

**29573** LOWER BOUND FOR THE FORWARD SCATTERING AMPLITUDE. Vernov, Yu. S.; Mnatsakanova, M. N. (Moscow State Univ.). Teor. Mat. Fiz.; 24: No. 1, 141-144(Jul 1975). (In Russian).

In the well known expression for the lower bound of the forward scattering amplitude: $\max_{E \to \infty} |f(E)| > C/E^2$ the expression for the constant C is found. A similar bound is obtained for finite energies. (auth)

**29574** THREE-PARTICLE INTERACTION IN THE SCATTERING ON BOUND STATE. Arkhipov, A. A.; Savrin, V. I. (Inst. of High Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.: 24: No. 1, 78-89(Jul 1975). (In Russian).

By means of the one-time formalism the relativistic generalization of the Glauber formula for the scattering on bound state is obtained. It is shown that there exists the contribution into the Glauber correction from three-particle interaction, which can be related to processes of multiple production in two-particle collisions. (auth)

**29575** SCATTERING AT LARGE ANGLES ON THE ANALYTICAL QUASIPOTENTIALS. Goloskokov, V. S.; Kuleshov, S. P.; Matveev, V. A.; Smondyrev, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 24: No. 1, 24-33(Jul 1975). (In Russian).

Scattering of high energy particles at large angles is investigated in the framework of the Logunov-Tavkhelidze quasipotential approach. It is shown that the scattering amplitude decreases as a power of s for a broad class of analytical quasipotentials. (auth)

**29576** COMBINATIONAL ANALYSIS OF THE OVERLAPPING PROBLEM FOR VERTICES WITH MORE THAN 4 TAILS. I. Some Topological Properties of Feynman Graphs. Pis'mak, Yu. M. (Leningrad State Univ.). Teor. Mat. Fiz.; 24: No. 1, 34-48(Jul 1975). (In Russian).

The definition of reducibility of a connected diagram is introduced, which makes it possible to extend the definition of reducibility of a diagram to the case $n > 4$, and also to formulate the definition of dressed n-tail vertex with n arbitrarily large. Some theorems about topological properties of diagrams with vertices of arbitrarily high order are proved. (auth)

**29577** SUPERGAUGE SYMMETRY AND SCALE DIMENSION OF FIELDS. Dao Vong Duc. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 24: No. 1, 49-53(Jul 1975). (In Russian).

On the basis of supergauge symmetry and scale invariance the relations for two-point and three-point correlation functions and the expressions for the scale dimension of fields in terms of the coupling constants are obtained. (auth)

**29578** TAKING INTO ACCOUNT THE INTERNAL LONGITUDINAL MOTION IN COMPOSITE SYSTEMS IN THE EIKONAL APPROXIMATION FOR RELATIVISTIC THREE-BODY PROBLEM. Kvinikhidze, A. N.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 24: No. 1, 54-61 (Jul 1975). (In Russian).

Eikonal approximation for the scattering on composite system is obtained in which the internal longitudinal motion of the constituents is taken into account. (auth)

**29579** LOWER BOUNDS FOR THE U-MATRIX. Tyurin, N. E. (Inst. of High Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 24: No. 1, 62-70(Jul 1975). (In Russian).

Lower bounds for the function U(s, t) connected with the scattering amplitude by means of a relativistic equation of damping theory are obtained. (auth)

**29580** QUANTIZATION OF THE CHIRAL THEORIES. Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 22: No. 3, 291-299(Mar 1975). (In Russian).

In terms of the Cartan forms the perturbation theory is developed, in which there are no rearrangements of matrix elements leading to changes in the structure of Feynman graphs (contractions of lines and reduction of the number of vertices). (auth)

**29581** REPRESENTATION FOR THREE-POINT FUNCTION. Usyukina, N. I. (Moscow State Univ.). Teor. Mat. Fiz.; 22: No. 3, 300-306(Mar 1975). (In Russian).

Representation for three-point function in terms of the Mellin integrals over all the three independent invariant variables is given. (auth)

**29582** LIMIT TRANSITION WITH RESPECT TO THE IMAGINARY ADDITIONAL MASS IN FEYNMAN AMPLITUDES. Slavnov, D. A. (Moscow State Univ.). Teor. Mat. Fiz.; 22: No. 3, 307-313(Mar 1975). (In Russian).

The problem of limit transition to zero value of the imaginary additional mass in chronological convolutions is reinvestigated. It is shown that this limit transition can be performed at the very beginning if the intermediate regularization in the products of chronological convolutions is removed. (auth)

**29583** PHASE UNCERTAINTY RELATION IN MULTIPARTICLE REACTIONS. Majernik, V. (Dept. of Physics, Nitra, Czech.). Acta Phys. Acad. Sci. Hung.; 38: No. 1, 79-81(1975).

Experimental analysis has confirmed the relation <n>/D = constant for charged-prong multiplicities where <n> is the average multiplicity and D represents the dispersion of the distribution. An attempt is made to find a dynamical reasoning for this equation. (SDF)

**29584** IMPLICATIONS OF UNITARITY FOR ELASTIC-SCATTERING AMPLITUDES. II. Bounds for the Absolute Value. Schwarz, F. (Univ., Kaiserslautern, Ger.). Nuovo Cim., 27A: No. 4, 360-372(21 Jul 1975).

Upper bounds for the absolute value of an elastic-scattering amplitude are derived if its value in the forward direction and the integral over the absolute value are given. The only assumption is the unitarity condition. The bounds obtained are rigorous in the sense that a violation by an elastic cross-section in a single point would imply the violation of unitarity in this process. (2 figures, 3 tables) (auth)

**29585** APPROXIMATIONS BASED ON THE T MATRIX FOR THE SUM OF SEVERAL POTENTIALS. Gupta, M. C.; Jain, A. K.; Marwadi, P. R.; Shastry, C. S. (Birla Inst. of Tech. and Science, Pilani, India). J. Phys., G (London): 1: No. 5, 516-527(20 Jun 1975).

Some approximations for obtaining T matrix elements for a sum of several potentials in terms of T matrices for individual potentials are studied. Calculations based on these methods are done for the S wave for the sum of two separable nonlocal potentials with Yukawa-type form factors and for the sum of two delta function type potentials. The results of these calculations are compared with the corresponding results of first- and second-order Born approximations and with exact calculations. It is found that the T matrix for a sum of potentials can be approximated satisfactorily by the sum of T matrices for individual potentials over all energy regions. This approximation is better than the first- and the second-order Born approximations. Another method for approximating the T matrix by breaking down the potential into a sum of a suitable number of square wells is presented. The on-shell T matrix for the Yukawa and Saxon–Wood potentials is calculated by this method, and good agreement is obtained with the corresponding exact results. To a good degree of accuracy, this approximation provides an interesting procedure in calculating the T matrix for arbitrary potentials in a simple way in terms of Bessel functions. The implications of this approximation in the theory of multiparticle collisions are discussed. (auth)

**29586** CONSTRUCTION OF COVARIANT BASES FOR TWO-PARTICLE REACTIONS. Tchrakian, D. H. (St. Patrick's Coll., Maynooth, Ireland). Fortschr. Phys.; 23: No. 3, 165-184(1975).

A method for the construction of the Lorentz-covariant bases occurring in the decomposition of spinor amplitudes (M-functions) of four massive particle processes is given. Each particle of spin- is described by a spinor state of the type-(s, O) and/or (O, s), but the essential parts of the method apply whatever the type of spinor state used, and the necessary relations between the hitherto familiar types of spinor states are given, by means of which the relation between the resulting sets of invariant amplitudes can be made explicit. By way of illustration four worked examples are presented. (auth)

**29587** VARIATIONAL BOUNDS FOR SCATTERING LENGTHS. Arthurs, A. M. (Univ. of York, Eng.). Phys. Rev., D; 11: No. 8, 2316-2319(15 Apr 1975).

New upper and lower variational bounds on scattering lengths for static potentials are presented. The derivation is based on dual extremum principles for linear equations L phi equals f, where L is a bounded linear operator. (auth)

**29588** IS THE POMERON RE-ABSORBED IN DIFFRACTION SCATTERING. Cohen-Tannoudji, G.; Maor, U. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique). Phys. Lett., B; 57: No. 3, 253-256(7 Jul 1975).

Unitarity s-channel corrections are shown to be responsible for the different properties of elastic and inelastic diffraction in impact parameter space. Model calculations with initial state absorption or eikonalization reproduce the observed peripherality of inelastic diffraction. (auth)

**29589** SCALING FUNCTION FOR DEEP INELASTIC HADRONIC SCATTERING. Crewther, D.; Joshi, G. C. (Univ. of Melbourne). Lett. Nuovo Cim.; 13: No. 13, 512-516(26 Jul 1975).

A generalization of the dual resonance amplitude model proposed by Bugrij, Jenkovsky, and Kobylinsky is used to describe the reaction a + b + x bar → a + b + x bar in the deep inelastic region. Scaling functions are obtained and computer calculated results are compared with available data and with results of a Veneziano model calculation. (SDF)

**29590** NEW METHOD FOR SOLVING THE MANY-BODY BOSON PROBLEM. II. Fung, P. C. W. (Univ. of Hong Kong); Tsang, H. K.; Wong, K. W. Nuovo Cim., B; 28B: No. 2, 313-348(11 Aug 1975).

Some relevant mathematical details for the new formalism of solving the many-boson problem proposed by Wong and Fung recently. Moreover, many of the infinite series appearing in the coefficients of the orthogonal states of the key equation are summed in closed form. An expression for the ratio of the matrix elements $M_{p,k}, N_{p,k}$ which diagonalize the Hamiltonian of the system is derived. To the lower orders of approximation one can express the three-particle correlation function in terms of the pair correlation functions in momentum space. (auth)

**29591** LARGE-ANGLE AMPLITUDE FOR POTENTIAL SCATTERING AT HIGH ENERGY. Chen, T. W. (Los Alamos Scientific Lab., NM); Hoock, D. W. Lett. Nuovo Cim.; 13: No. 11, 389-392(12 Jul 1975).

A previously derived equation for the elastic large angle amplitude for scattering by a potential is shown to reduce to a much simpler form and its utility is illustrated through an example. The formula is contrasted with usual eikonal type approximations. (1 Table, 2 Figures) (SDF)

**29592** THRESHOLD SINGULARITIES OF THE S-MATRIX AND CONVERGENCE OF HAAG–RUELLE APPROXIMATIONS. Buchholz, D. (Hamburg Univ. (F. R. Germany). 2. Inst. fuer Theoretische Physik). Commun. Math. Phys.; 39: No. 3, 221-241 (Dec 1974).

9 refs.

A one-to-one correspondence is established between the continuity properties of the S-matrix at the 2-particle threshold and the rate of convergence of the Haag–Ruelle approximations PSI(t) for asymptotic 2-particle states PSI with smooth wave functions. It turns out that the norm distance PSI–PSI(t) approaches 0 like $t^{-\frac{1}{2}}$ if the S-matrix has the normal threshold singularities and like $t^{-\frac{3}{4}}$ in the exceptional case where the threshold has "absorbed" a bound state. These connections are valid both in relativistic quantum field theory and in nonrelativistic models with short range interaction. (auth)

**29593** PARAMETRIC REPRESENTATIONS OF FEYNMAN GRAPHS. Zav'yalov, O. I. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 23: No. 3, 291-299(Jun 1975). (In Russian).

Operators of finite renormalization which perform arbitrary shift of the subtraction point in the R-operation are evaluated. Parametric representations of divergent graphs are generalized for the case of the finite renormalization of two-particle subgraphs of the graph. (auth)

**29594** ANALYTICAL PROPERTIES OF THE U-MATRIX. Savrin, V. I.; Tyurin, N. E. (Inst. of High Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 23: No. 3, 348-354(Jun 1975). (In Russian).

Analytical properties of the generalized reaction matrix (the U-matrix) in the momentum transfer variable are studied. (auth)

**29595** TOPOLOGICAL PROPERTIES OF LANDAU CURVES IN THE CONNECTION WITH THE MANDELSTAM HYPOTHESIS. Enol'skii, V. Z. (Inst. of Theoretical Physics, Kiev). Teor. Mat. Fiz.; 23: No. 3, 335-347(Jun 1975). (In Russian).

Feynman amplitude $F_G$ associated with the Feynman graph G is considered for the case of the scalar scattering reaction of the 1 + 2 → 3 + 4 type. Sufficient conditions of validity of the Mandelstam hypothesis are found as conditions on the Landau curves $L_G$ for the amplitude $F_G$, $G \in R$ where R is a certain class of the Feynman graphs introduced. Application of the criteria obtained to the ladder graph is considered. (auth)

**29596** PARTICLE IN RESULTING FIELD OF FIXED CENTERS. Dalidchik, F. I. (Inst. of Chemical Physics, Moscow). Teor. Mat. Fiz.; 23: No. 3, 427-430(Jun 1975). (In Russian).

Derivation of the exact system of algebraic equations for quantities determining the Green function and the wave function of a particle in resulting field of arbitrary fixed scattering centers. The equations obtained are written out in terms of scattering amplitudes corresponding to the "internal" and "external" parts of two-particle potentials and may be extended simply to the cases of particles with nonzero spin, many-channel scattering and nonpotential interactions. (auth)

**29597** THE RADIUS OF THE POMERON AND ABSORPTIVE CUTS. Schwimmer, A.; Zachariasen, F. (California Inst. of Tech., Pasadena (USA)). Phys. Lett., B; 57: No. 4, 357-360 (21 Jul 1975).

It is pointed out that absorption in quantum number exchange two-body reactions with a Pomeron whose radius in impact parameter is proportional to log s, and whose opacity is not totally black, yields singularities which, asymptotically, are dominated

for all t by the original Regge pole. Thus for such Pomerons, in the limit of infinite energy, the simple phenomenology associated with pure Regge pole exchange should be valid. (auth)

**29598** FACTORIZATION IN TWO-BODY REACTIONS. Joshi, G. C.; Lo, S. Y. (Melbourne Univ., Parkville (Australia). School of Physics). Nucl. Phys., B; 93: No. 3, 405-414(28 Jul 1975).

Factorization is one of the simple principles that is incorporated in most models in high energy scatterings at small t region. It was subjected previously to direct experimental tests in various instances. The aim of this investigation is to study factorization for $\pi$, $\rho$ and vacuum exchanges in all two-body reactions where experimental data are available. (auth)

**29599** THE PARITY OF REGGE CUTS. Jones, L. M.; Landshoff, P. V. (Cambridge Univ. (UK). Dept. of Applied Mathematics and Theoretical Physics). Nucl. Phys., B; 94: No. 1, 145-162(4 Aug 1975).

The exchange of two reggeons of naturalities $\eta_a$ and $\eta_b$ will in general produce a J plane cut in amplitudes of both naturalities $\pm \eta_a \eta_b$. It is shown that the amplitudes of naturality $-\eta_a \eta_b$ are suppressed, and this suppression grows with energy, regardless of the particular model used for the vertices coupling the reggeons to the external particles. In consequence, for cuts where the two reggeons are any of $\rho$, $A_2$, f, $\omega$, or the pomerons, the natural-parity cut (if it is present) will dominate over the unnatural parity. It is also shown that cut vertices which contribute to both naturalities satisfy the conspiracy condition at t = 0 by suppressing both contributions equally. Away from t = 0, the $\eta = +\eta_a \eta_b$ contribution can recover from this suppression. This behavior is of importance in, for example, the pion-pomeron cut. These conclusions are compared with experiment. (auth)

**29600** A MODIFIED K-MATRIX APPROACH TO MANY-CHANNEL PROCESSES. Lang, C. B. (Karlsruhe Univ. (TH) (F. R. Germany). Inst. fuer Theoretische Kernphysik). Nucl. Phys., B; 93: No. 3, 415-428(28 Jul 1975).

The definition of a K-matrix, that does not have the direct channel singularities of the scattering amplitude, is not unique. Different choices lead to different integral equations for K with different physical content. The choice where the intermediate states have a simple off-shell behavior for each partial wave is discussed. Crossing leads to an identification of the singularities of the K-matrix elements and to an iterative method of finding the scattering amplitude starting from a "bare" world. (auth)

# PHYSICS (LOW-TEMPERATURE)

## Superconductivity

*Refer also to abstracts 28376, 28384, 28387, 28410, 28461, 28467, 28468, 28472, 28476, 28504, 28528, 28543–28547, 28598, 28682, and 28683.*

**29601** (JINR-P4-8940) EFFECT OF A PEIERLS-TYPE INSTABILITY ON THE SUPERCONDUCTING PHASE TRANSITION. Brankov, I. G.; Tonchev, N. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 24p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

An exactly soluble model for a superconductor with a structural instability is investigated. The gap equations are solved in the weak-coupling limit. The functional dependence of the superconducting gap on the parameters of the system is obtained in two limiting cases: $\omega_D \gg \mu_\theta$ and $\omega_D \ll \mu_\theta$, where $\omega_D$ is the Cooper pairing cutoff energy, $\mu_\theta$ the shift of the chemical potential from the center of the band. (auth)

**29602** (JINR-P4-8951) SUPERCONDUCTING LONG-RANGE ORDER IN ONE- AND TWO-DIMENSIONAL SYSTEMS. Kharrasov, M. Kh. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The conditions have been studied leading to one- and two-dimensional superconducting states. (auth)

**29603** (JINR-R-4-8150) AN EXACTLY SOLUBLE MODEL FOR SUPERCONDUCTORS WITH ELECTRON-HOLE PAIRING. Brankov, I. G.; Tonchev, N. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 16p. (In Russian). INIS.

14 refs.

An asymptotic precise solution was obtained for the model of a single-zone metal with simultaneous consideration of Cooper and electron-vacancy coupling. In the case considered of a half filled zone, a region of dielectric and superconducting phase was found. In the theory presented the presence of a structural transition phase does not lead to an increase in the critical temperature of the superconductor. (tr-auth)

**29604** ELECTROMAGNETIC INTERACTION IN SUPERCONDUCTOR NEAR T/sub c/ IN PRESENCE OF SMALL MAGNETIC FIELD: NEW QUASIPARTICLE EXCITATION SPECTRUM IN THE ACOUSTIC ATTENUATION IN THE INTERMEDIATE STATE OF A SUPERCONDUCTOR. Lin, F. J. Washington, DC; Catholic University of America (1975). 100p. University Microfilms Order No. 75-14,962.

Thesis (Ph. D.).

Quasiparticle scattering at N–S interfaces in the intermediate state leads to a modified quasiparticle energy spectrum. We report finding this spectrum in the acoustic attenuation in In near T/sub c/. A theoretical model is given which accounts for the observed attenuation structure in terms of the modification of the density-of-states rho(E) produced by the N–S "superlattice". Unique conditions in the present work have led to discovery of the new features: Since T/sub c/ – T approximately less than 5 mK acoustic phonon energy h omega/2pi approximately 0.01 DELTA(T), the BCS energy gap. We find this energy to be comparable with the band width and band separation in the new quasiparticle energy spectrum just above DELTA(T), so that modified rho(E) can have measurable effect on the observed attenuation due to phonons of energy h omega/2pi. The observed temperature dependence of the attenuation structure is shown to be in good agreement with that determined from the theoretical model using the new quasiparticle density-of-states. (auth)

**29605** SUPERCONDUCTIVITY IN Zr/sub x/Nb/sub 1-2x/Mo/sub x/ ALLOYS: POSSIBLE DOMINANCE OF A SOFT PHONON MODE. Ishikawa, M.; Cappelletti, R. L. (Ohio Univ., Athens). J. Low Temp. Phys.; 20: No. 3/4, 407-422(Aug 1975).

Normal-state specific heat and superconducting transition temperature measurements were performed on pure polycrystalline Nb and isoelectronic bcc Zr/sub x/Nb/sub 1-2x/Mo/sub x/ alloys (x equals 0.02, 0.05, and 0.10). Measured T/sub c/ gamma and theta/sub D/ all decline nearly linearly from the pure Nb values with increasing x. The changes are 15, 10, and 6 percent, respectively, for x equals 0.1. T/sub cH/ calculated by Hopfield's theory, using data and linearly interpolated values of eta and theta/sub D//root [theta$^2$]/sub linear/, increases with x by 28 percent for x equals 0.1. By relaxing the linear interpolation of theta/sub D//root [theta$^2$], Hopfield's theory can be used to evaluate an average phonon frequency [theta$^2$]/sub emp/ from data. It is found to be nearly constant at about 229°K, in contrast to root [theta$^2$]/sub linear/, which declines by 8 percent at x equals 0.1. We suggest that one possible explanation for this behavior is the dominance of incipient soft-phonon longitudinal modes which occur in Nb and presumably in the alloys. Miedema's method has been used to calculate the variation of both gamma and T/sub c/ with alloying. The calculated gamma is nearly constant, while the calculated T/sub c/ declines more quickly than the measured variation. The band-structure electron density of states calculated with the aid of McMillan's equation for these isoelectronic alloys is found to decline by 8 percent at x equals 0.1, in contrast to the prediction of the rigid band model. Normal-state low-temperature specific heat measurements on a pure annealed polycrystalline sample of Nb yield gamma equals 7.80 +- 0.02 mJ mole$^{-1}$ K$^{-2}$ and theta/sub D/ equals 276 +- 2 K, in excellent agreement with previous measurements. The break in slope of C/sub p/T vs. T$^2$ at 3.2 K is discussed. (6 figures, 1 table) (auth)

**29606** HEAT CONDUCTION IN THE INTERMEDIATE STATE OF SUPERCONDUCTORS: OBSERVATION OF A NEW SIZE EFFECT IN LEAD. Suter, J. M.; Rothen, F.; Rinderer, L. (Lausanne, Univ., Switzerland). J. Low Temp. Phys.; 20: No. 3/4, 429-436(Aug 1975).

Experimental evidence is presented for the existence of a size effect predicted by Andreev as a consequence of his quasiparticle reflection law at the superconducting–normal interphase boundaries. In high-purity lead we observe a reduction of the thermal conductivity in the intermediate state when the heat current is parallel to the laminar structure. (2 figures, 1 table) (auth)

**29607** THEORY OF THE SUPERCONDUCTING PROXIMITY EFFECT. Silvert, W. (Dalhousie Univ., Halifax, Nova Scotia). J. Low Temp. Phys.; 20: No. 5/6, 439-477(Sep 1975).

The Gor'kov theory of the proximity effect has been solved to a high degree of accuracy by a numerical variational method for a system of two metallic films of finite thickness. The results are analyzed in the context of exact sum rules for the Gor'kov theory and compared with those obtained from various approximate theories, including diffusion theories. It is found that for thin films the order parameter varies considerably more rapidly than is predicted by local theories (e.g., Ginzburg–Landau) and that the different diffusion theories are quite unreliable. (9 figures, 33 references) (auth)

**29608** BOGOLIUBOV EQUATIONS, BOUNDARY CONDITIONS, AND THE FREE ENERGY OF INHOMOGENEOUS SUPERCONDUCTORS: A NEW METHOD. Eilenberger, G.; Jacobs, A. E. (Kernforschungsanlage, Juelich, Germany). J. Low Temp. Phys.; 20: No. 5/6, 479-521(Sep 1975).

A new formulation of the theory of inhomogeneous superconductors is described, and is applicable to all cases in which the Bogoliubov equations reduce to ordinary differential equations, and intermediate between the Bogoliubov, or wave function, and Gor'kov, or Green's function, formulations; the method is illustrated for the simple case of zero magnetic field, but a generalization appears straightforward. The method is based on the former formulation, and hence is well suited for the investigation of boundary effects; neither the wave functions nor the energy eigenvalues are required, however, for either the free energy or the self-consistency equation. It is shown that the free energy can be expressed in terms of a single function E, derive integral and differential equations for E, and give a thorough discussion of its properties. We also show that the self-consistency equation for the order parameter DELTA(x) can be expressed in terms of E and a generalization of it. The new formulation is applied in two investigations of the question of anomalous terms in the free energy near the transition temperature. First, the free energy is calculated for arbitrary DELTA(x), but only to terms quadratic in DELTA (x) and its derivatives; it is shown that anomalous terms occur if, and only if, either some odd-numbered derivative of DELTA(x) fails to vanish at a free surface, or DELTA(x) (or one of its derivatives) is discontinuous. Second, the free energy is calculated to all orders in DELTA(x) for four models in which E can be obtained analytically, illustrating the conclusions of the first investigation, and resolving a contradiction in the literature. (auth)

**29609** GENERALIZATION OF ABRIKOSOV'S SOLUTION OF THE GINZBURG–LANDAU EQUATIONS. Kogan, V. G. (Technion-Israel Institute of Tech., Haifa, Israel). J. Low Temp. Phys.; 20: No. 1/2, 103-115(Jul 1975).

The Ginzburg–Landau (GL) equations for type II superconductors near the upper critical field H/sub c2/ permit a more general solution than Abrikosov's. It turns out that already in the first approximation it is possible to build the solution for

H less than H/sub c2/. All of the basic Abrikosov results also remain correct for these expressions. The new solutions describe the system of vortices that can form a nonperiodic structure and may contain an arbitrary number of magnetic flux quanta. The Abrikosov structure is the particular case of the general solution in which the centers of the identical vortices form the periodic structure. The GL energy as a function of the center positions has a minimum for a periodic structure. The validity region of these solutions is estimated. It may be wider than the similar regions for the Abrikosov case. The simple approximate expressions for the vortex structure are obtained, and the algorithm for the higher approximations is indicated. (1 figure) (auth)

**29610** KONDO EFFECT IN SUPERCONDUCTORS: DEPRESSION OF THE TRANSITION TEMPERATURE. Sundaram, R. (National Physical Lab., New Delhi). J. Low Temp. Phys.; 20: No. 1/2, 117-122(Jul 1975).

The influence of magnetic impurities on the transition temperature of superconducting alloys is investigated by means of the higher order parquet theory, which is essentially a self-consistent renormalization of the s-d interaction vertex and the quasi-fermion self-energy. The effective electron-electron interaction is evaluated beyond the logarithmic approximation, in terms of the renormalized spin-flip amplitude, which is responsible for the pair-breaking effect of the magnetic impurities. An expression for the maximal pair breaking, which is dependent on the spin and the superconducting coupling constant, is derived. (2 figures) (auth)

**29611** PROPERTIES OF SUPERCONDUCTING ALLOYS CONTAINING KONDO IMPURITIES. Schlottmann, P. (Max-Planck-Institut fur Physik und Astrophysik, Munich). J. Low Temp. Phys.; 20: No. 1/2, 123-154(Jul 1975).

The phase transition temperature T/sub c/ and the specific heat discontinuity DELTA C of a superconductor containing Kondo impurities are expressed self-consistently in terms of the t-matrix for Kondo scattering, which has been calculated within the Tomonaga approximation, thereby taking care of the infrared singularities. The approximation contains the Abrikosov-Gor'kov theory and the exact result for the classical spin as limiting cases. The initial slopes of T/sub c/ and DELTA C as a function of antiferromagnetic exchange coupling have a maximum, and the zero-temperature transition concentration has a minimum, showing that the impurity undergoes a magnetic-nonmagnetic transition when the coupling is increased. This agrees with previous results for the impurity spin susceptibility. The condition for a reentrant phase boundary is discussed in connection with its implications for the specific heat jump. The results are compared quantitatively with experimental data for $LaAl_2$ containing Ce and Gd impurities and qualitatively with recent data for the Ce system. (10 figures, 48 references) (auth)

**29612** KAPITZA CONDUCTANCE OF METAL SINGLE CRYSTALS BY THE SECOND SOUND TECHNIQUE. Wagner, F.; Kollarits, F. J.; Wilkes, K. E.; Yaqub, M. (Ohio State Univ., Columbus). J. Low Temp. Phys.; 20: No. 1/2, 181-206(Jul 1975).

The Kapitza conductance h/sub K/ of high-purity single crystals of gallium, copper, lead, and tin, between 1.2 and 2°K, has been determined by an improved version of the second sound method developed by Challis and Sherlock. By using a special mounting technique, strains in the samples were avoided on cooling. A comparison of the results with those given in the literature shows that our values of h/sub K/ are consistently higher than those obtained by using the steady-state method. By introducing different amounts of strain in a given sample its h/sub K/ was reduced by corresponding amounts. Thus, for a given metal, the entire range of reported steady-state values was covered. In the region of 1-2°K, strain not only reduces h/sub K/, but also increases the temperature dependence considerably. Although a reduction of h/sub K/ with strain has been reported with the steady-state measurements, it is not accompanied by an increase in the temperature dependence. Possible reasons for this are discussed. Study of the superconductors lead and tin shows that the temperature exponent is nearly the same in the superconducting and normal states. The absolute value of h/sub K/ decreases in lead typically by 6 percent and increases in tin by 5 percent. (auth)

**29613** LINEARIZED KINETIC EQUATIONS AND RELAXATION PROCESSES OF A SUPERCONDUCTOR NEAR T/sub c/. Schmid, A.; Schoen, G. (Dortmund Univ., West Germany). J. Low Temp. Phys.; 20: No. 1/2, 207-227(Jul 1975).

Starting from the equation of Gor'kov and Eliashberg in a form introduced by Eilenberger, a set of linearized equations is derived for the deviation from the equilibrium value of the quasiparticle distribution function as well as of the order parameter. These equations resemble the Boltzmann equation and the Ginzburg-Landau equation, respectively, and they form a set of coupled equations. Two different modes can be distinguished, depending on whether the order parameter changes in magnitude or in phase. The equations are solved for the case of a stationary quasiparticle injection into a superconductor and the change in the electrochemical potential of the quasiparticles is calculated. Furthermore, the problem of a current flowing perpendicular to a superconducting-normal interface in which a normal current is converted into a supercurrent is treated and the extra resistance of the interface is calculated. (4 figures, 1 table) (auth)

**29614** MODEL FOR AN EXCITON MECHANISM OF SUPERCONDUCTIVITY IN PLANAR GEOMETRY. Allender, D. W. Urbana, IL; University of Illinois (1975). 81p. University Microfilms Order No. 75-14,075.

Thesis (Ph. D.).

The possibility of an exciton mechanism of superconductivity in planar geometry is investigated. Upon specialization to the case of the single interface between a thin, crystalline metal film in intimate contact with a clean semiconductor substrate, a model is developed in which the metal electrons with energies near the Fermi surface penetrate a short distance into the semiconductor. There they scatter by producing and absorbing virtual electron-hole pairs. The effect of such semiconductor polarization processes (i.e., the exciton mechanism) on the electron-electron interaction is estimated by two separate means and is found to lead to an attractive interaction for favorable choices of semiconductor and metal materials. A brief look at attempts to derive these results in terms of the microscopic dielectric function is also given. A calculation of what superconducting transition temperatures one could expect to see due to this effect follows, both for the case of the exciton mechanism acting alone, and for the case of the exciton mechanism combined with the usual phonon mechanisms. It is concluded that although the exciton mechanism has not yet been established experimentally, the theory has a sound physical basis and indicates that the effect of the exciton mechanism ought to be observable in favorable samples with sufficient effort. The immediate need is to fabricate such systems and establish the existence of the exciton mechanisms of superconductivity. (auth)

**29615** CURRENT FLOW IN INHOMOGENEOUS SUPERCONDUCTORS. Johnson, J. L. Urbana, IL; University of Illinois (1974). 143p. University Microfilms Order No. 75-11,793.

Thesis (Ph. D.).

The change of normal current flow into supercurrent flow is examined in a number of problems in which the pair potential of the superconductor can vary spatially. We examine approximate solutions to the Bogoliubov equations in the limits that the pair potential, DELTA(vector r), varies quickly or slowly compared to a coherence length, Xi/sub c/(T), to see how well such solutions conserve charge flux. These solutions are then used to compute the linear current response of a superconductor in these two limits. Scattering is included using the Mattis-Bardeen scattering technique. Using the step-like pair potential the linear current response of a superconducting-normal (SN) junction as well as NSN, SNS, and layered structures SNSN . . . as occur with a static electric field applied normal to the boundaries is calculated. The results for the self-consistent currents and fields are found to be the same in certain limits as those found by other investigators who used semiphenomenological approaches. The linear current response of a superconductor with a pair potential which varies slowly over a coherence length to an applied alternating electric field is also examined. This result should be useful in describing the current response of very wide superconducting-normal-superconducting (SNS) junctions in which a very small pair potential exists in the "normal" region at very low temperatures in the millidegree range. (Diss. Abstr. Int., B)

**29616** INELASTIC NEUTRON SCATTERING FROM TYPE-II SUPERCONDUCTORS. Sacks, R. A. Stanford, CA; Stanford University (1975). 98p. University Microfilms Order No. 75-13,591.

Thesis (Ph. D.).

The scattering of neutrons by a type-II superconductor in the mixed state is treated using Fetter's quantized hydrodynamic theory for the superfluid vortex lattice. Maki's first-order calculation, which involved a single vibrational quantum in a lattice of rigid vortices, predicted a series of quadratic singularities in the inelastic cross section. This divergence is shown to arise from the first-order expansion and is therefore unphysical. A treatment to all orders in the lattice displacements shows that the neutron propagator is renormalized by the emission and absorption of equivalent lattice quanta, and this renormalization effect eliminates Maki's singularity. The resulting cross section consists of a series of negligibly broadened elastic Bragg peaks and thus contains no information about the lattice dynamics.

Inclusion of the bending modes of lattice excitation modifies this result and offers the hope of testing Fetter's description. The small induced perpendicular magnetic fields can change the projection of the neutron spin along the applied field direction. The dependence of this spin-flip cross section on both scattering angle and initial spin direction is related directly to characteristic properties of the vortex lattice. The bending modes also affect the non-spin-flip cross section. While the primary feature of non-flip scattering is still a series of sharp Bragg peaks, an additional much broader signal "above" and "below" these peaks also occurs. Unfortunately, estimates of these cross sections show that neither of these interesting quantities can presently be observed. Crucially involved throughout this work are four rather complicated lattice sums from Fetter's theory. While these sums cannot be evaluated exactly, they are easily approximated in two different limits: long-wavelength excitations and dense lattice. The scattering calculation has been carried out using each approximation, with good qualitative agreement between the two results. (Diss. Abstr. Int., B)

**29617** EFFECT OF THE FREQUENCY DEPENDENCE OF THE ELECTRON–PHONON INTERACTION SPECTRAL FUNCTION ON THE THERMODYNAMIC PROPERTIES OF SUPERCONDUCTORS. Karakozov, A. E.; Maksimov, E. G.; Mashkov, S. A. (Inst. of High Pressure Physics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1937-1950(May 1975). (In Russian).

The thermodynamic properties of superconductors are investigated. It is shown that due to decay elicited by interaction between Cooper pairs and thermal phonons, the electron density of states in real superconductors does not vanish anywhere. It is noted that this effect is similar to the influence of magnetic impurities. In contrast to the latter, however, this does not lead to a lowering of $T_c$. Approximate formulas for $T_c$ are derived and compared with the familiar MacMillan formulas. The range of applicability of the formulas is established by comparing them with the exact numerical solution of the Eliashberg equations. The dependence of $T_c$ on the shape and position of the phonon density of states is investigated. It is shown that the increase of $T_c$ due to the softening of the phonon spectra is possible only when the electron coupling constant increases. (auth)

**29618** NONLINEAR CONDUCTIVITY OF SUPERCONDUCTORS IN THE MIXED STATE. Larkin, A. I.; Ovchinnikov, Yu. N. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1915-1927(May 1975). (In Russian).

The volt-ampere characteristic of superconductors in the mixed state possesses an N-like shape. Due to the large energy relaxation time nonlinear effects appear in comparatively weak electric fields when the transport current is much smaller than the critical unpairing current. (auth)

**29619** PREDICTION OF AN INTRINSIC HYSTERESIS AT $H_{c1}$ FOR TYPE-II/1 SUPERCONDUCTORS. Leplae, L.; Srinivasan, V.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Nuovo Cim., 28B: No. 1, 39-55(11 Jul 1975).

It is shown that the attractive interactions between flux lines which are responsible for the first-order phase transition of type-II/1 superconductors at $H_{c1}$, also imply the existence of a phenomenon of hysteresis at $H_{c1}$, which depends only on the properties of the flux lines. The calculated magnitude of the width of this hysteresis is of the same order of magnitude as the width of the irreversibility observed recently by Auer and Ullmaier, suggesting that those experiments were done under conditions close to the ideal conditions under which the intrinsic hysteresis would dominate. It is also shown that a careful measurement of the hysteresis would yield a lot of information on the structure of the flux lines. (7 figures) (auth)

**29620** KINETIC COEFFICIENTS FOR SUPERCONDUCTING ALLOYS. Vladimir, M. I.; Moskalenko, V. A.; Niki, Yu. N. (Inst. of Applied Physics, Kishinev, USSR). Teor. Mat. Fiz.; 24: No. 1, 115-128(Jul 1975). (In Russian).

The presence of paramagnetic admixtures in superconductors results in the smearing of the density of electron states near the boundary of the spectrum. This smearing removes the singularity in the velocity of the nuclear spin relaxation. On the basis of the admixture mechanism the kinetic coefficients of superconducting alloys are calculated. (auth)

**29621** RELAXATION OF NUCLEAR SPIN IN ADMIXED SUPERCONDUCTORS. Gurgenishvili, G. E.; Nersesyan, A. A.; Kharadze, G. A. pp 164-171 of Ekektronnye i Ionnye Protsessy v Tverdykh Telakh. VII. Tbilisi, USSR; Izdatel'stvo Metsniereba (1974). (In Russian).

The subject is developed mathematically. Relaxation of nuclear spin in metals is brought about by thermal modulation of hyperfine interaction. Addition of magnetic impurities to superconductors distorts the spectral density. Besides renormalizing the single-electron state, the presence of paramagnetic impurities results in an additional spin correlation between conducting electrons, which affects the fluctuations in the hyperfine field acting on nuclear spin. It is reasonable to suggest that there should be a minimum in the temperature dependence curve of the nuclear relaxation rate in doped superconductors. (TTT)

**29622** GETTING WARMER IN THE SUPERCONDUCTIVITY GAME. Rivlin, V. (Fulmer Research Inst. Ltd., Stoke Pages, Eng.); Dew-Hughes, D. New Sci.; 67: No. 960, 261-264(31 Jul 1975).

The progress made since 1941 in the search for alloys capable of superconductivity at temperatures higher than the values (0.01 K to 9K) characteristic of the metallic elements is outlined. At the moment the record is held by $Nb_3Ge$, and A-15 alloy, which has a transition temperature ($T_c$) of 23.2K. The possibility that other A-15 alloys could possibly have even higher values of $T_c$ is explored, though the practical limit for $T_c$ of these compounds may have already been reached. If this is so, further improvements in $T_c$ must be sought in new compounds, such as the recently discovered ternary (or possibly quaternary) sulphides. (UK)

**29623** DIFFRACTION EFFECTS IN THE JOSEPHSON TUNNELING BETWEEN TYPE II SUPERCONDUCTORS NEAR $H_{c1}$. Leung, M. C. (Kernforschungsanlage, Juelich, Ger.). Solid State Commun.; 17: No. 4, 537-539(15 Aug 1975).

When the lattice of vortices on one side of a SIS tunneling junction moves with respect to that of the other side, it is pointed out that the Josephson current should oscillate in magnitude and direction as a function of time. The oscillatory behavior is caused mainly by the diffraction effects of the variation of the order parameter in the mixed state with vortex motion. (auth)

**29624** TRANSITION TEMPERATURE AND SPECIFIC HEAT DISCONTINUITY FOR SUPERCONDUCTING ALLOYS CONTAINING KONDO IMPURITIES. Schlottmann, P. (Max Planck-Institut fuer Physik und Astrophysik, Munich). Solid State Commun.; 16: No. 12, 1297-1300(15 Jun 1975).

The dependence of the transition temperature and the specific heat discontinuity of a superconductor on the magnetic impurity concentration is calculated selfconsistently using the spin-boson approach for the Kondo problem. The results agree well with experimental data for the (La, Ce)$Al_2$ alloy. (auth)

# PHYSICS (NUCLEAR)

**29625** (ORO-3820-28) ON-LINE HIGH-RESOLUTION MASS SPECTROSCOPY. Progress Report, January 1, 1975–July 1, 1975. Macfarlane, R. D. (Texas Agricultural and Mechanical Univ., College Station (USA). Cyclotron Inst.). 1975. Contract AT(04-1)-3820. 15p. Dep. NTIS $4.00.

The report begins with a brief introduction, summary of activities, and lists of personnel, facilities used, publications, and presentations. Work on xanthine–tyrosine and sulfuric acid esters was completed in the project on $^{252}$Cf-plasma desorption mass spectroscopy of involatile molecules. Work is continuing in the following areas: beta–gamma directional correlations and second-class currents in nuclear beta decay (mass-20 system), beta–neutrino directional correlations in mass 8, atomic mass measurements, and $^{252}$Cf-plasma desorption mass spectroscopy of large biomolecules. (3 figures) (RWR)

**29626** (UCID-16904) E DIVISION ACTIVITIES REPORT: FY 1975. Barschall, H. H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Sep 1975. Contract W-7405-eng-48. 9p. Dep. NTIS $4.00.

This report describes some of the activities in E (Experimental Physics) Division. E Division carries out basic and applied research in atomic and nuclear physics, centered around the Laboratory's four major accelerators. Experiments are grouped under the headings of neutron, photon, and charged-particle interactions. Investigations in this fiscal year involved fission cross sections, neutron transport, quasielastic scattering, gamma rays from radiative capture of neutrons, 14-MeV-neutron-induced radiation damage, inner-shell vacancies produced in collisions between ions and atoms in solid and gas targets, fissile materials safeguarding, and biomedical applications. (auth)

**29627** INTRODUCTION TO EXPERIMENTAL NUCLEAR PHYSICS. Singru, R. M. New York; John Wiley and Sons, Inc. (1974). 170p. $6.95.

This book is comprised of ten chapters. Chapter 1 introduces basic properties of nuclei, nuclear radiation and nuclear decay while chapter 2 briefly summarizes the main features of nuclear reactions. The interaction of nuclear radiation with matter is described in chapter 3. An introduction to various nuclear radiation detectors, including the newly developed semiconductor radiation detectors is provided in the next chapter. Chapters 5, 6, and 7 describe the various techniques used to measure alpha rays, beta rays, and gamma rays. Chapter 8 summarizes the special techniques designed to render the nuclear techniques more powerful. Chapter 9 provides an interface between the experimental nuclear techniques and nuclear physics studied by these techniques. Chapter 10 introduces areas like positron annihilation studies, Mossbauer spectroscopy, and perturbed angular correlation where nuclear techniques form methodology. Emphasis is placed on radioactive nuclear decay processes rather than on nuclear reactions. (BJG)

## Neutron Interactions with Matter

*Refer also to abstract 29616.*

**29628** (INIS-mf-1733, pp 40-53) DIFFERENTIAL NETWORK METHOD AND ITS APPLICATION IN SOLVING THE DIFFUSION EQUATION. Krysl, V.; Wohlmut, J. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

The solution of the multi-velocity diffusion equation in two-dimensional geometry applying the differential network method is described. The basic set of linear algebraic equations is derived and the methods of solution are briefly outlined. The respective elements of the diffusion equation and the boundary conditions are discussed. (INIS)

**29629** (INR-1447/CYFRONET/PM/A) TWO-SWEEP ITERATIVE METHODS FOR SOLVING LARGE LINEAR SYSTEMS AND THEIR APPLICATION TO THE NUMERICAL SOLUTION OF MULTI-GROUP MULTI-DIMENSIONAL NEUTRON DIFFUSION EQUATION. Woznicki, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1973. 139p. INIS.

The two-sweep iterative methods described for solving large systems of linear equations are a generalization of the procedure "forward elimination–backward substitution" used up to now only as the direct method (the Gaussian elimination) for solving systems of linear equations with tridiagonal matrices. The theoretical foundations of the two-sweep iterative methods are described on the basis of the theory of nonnegative matrices. The numerical results presented show that the application of the two-sweep methods to the numerical solution of the multi-dimensional neutron diffusion equations provides a considerable acceleration of the convergence in comparison to other iterative methods. (auth)

**29630** (ITP-75-38E) NEUTRON SCATTERING DUE TO PAIRS OF ISOTOPIC IMPURITIES IN A CRYSTAL. Dudkin, S. I. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1975. 17p. Dep. NTIS (US Sales Only) $4.00.

The method for calculating expressions of the complex admittance type previously proposed [ITP-70-110P, Phys. Stat. Sol. (b), 60, 191 (1973)] is extended to impurity systems. The model problem is considered in detail for the one-phonon cross section for inelastic scattering of neutrons by crystals containing a pair of impurities, on the assumption that defect atoms have only a different mass from the atoms of the host crystal and that the force constants are unchanged. (auth)

**29631** (JINR-R-14-7979) DIFFRACTION OF POLARIZED NEUTRONS ON A $^{186}$W SINGLE CRYSTAL LOCATED IN A MAGNETIC FIELD. Mikhalets, R.; Sedlakava, L. N.; Chalupa, B.; Aleksandrov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 8p. (In Russian). INIS.

7 refs.; 1 fig.

Diffraction of polarized neutrons on a $^{186}$W single crystal located in a magnetic field was studied. For the [220] reflection, with increase in the magnetic field there was an anomalous increase in the polarization ratio. (tr-auth)

**29632** (ORNL-TM-5024) MEASUREMENT OF SECONDARY NEUTRONS AND GAMMA RAYS PRODUCED BY NEUTRON INTERACTIONS IN SILICON DIOXIDE OVER THE INCIDENT ENERGY RANGE 1 TO 20 MeV. Morgan, G. L. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. 32p. Dep. NTIS $4.00.

The spectra of secondary neutrons and gamma rays produced by neutron interactions in a thick (approximately 1 mean free path) sample of silicon dioxide have been measured as a function of the incident neutron energy over the range 1 to 20 MeV. Data were taken at an angle of 90°. A linac (ORELA) was used as a neutron source with a 47-m flight path. Incident energy was determined by time-of-flight, while secondary spectra were determined by pulse-height unfolding techniques. The results of the measurement are presented in forms suitable for comparison to calculations based on the evaluated neutron data files. (6 tables, 4 figures) (auth)

**29633** (WARD-XS-3045-9) PHYSICS EVALUATIONS AND APPLICATIONS QUARTERLY PROGRESS REPORT FOR PERIOD ENDING APRIL 30, 1975. Davis, W.; Bortz, A. B.; Yarbrough, M. B.; Paik, N. C. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jun 1975. Contract E(11-1)-3045. 12p. AT.

Current progress may be briefly summarized as follows. All major coding work was completed on the SPHINX data processing code. SPHINX was extensively tested with an ENDF/B-IV 50-group cross section library with $P_3$ scattering components produced by the MINX code, as well as with ETOX-produced ENDF/B-III and ENDF/B-IV cross sections. SPHINX was also tested by using the 5-isotope set of 240 group MINX cross sections. The ENDF/B-IV 50-group cross section library was tested by performing SPHINX calculations of CSEWG benchmarks ZEBRA-3, JEZEBEL, ZPR-6-7, and ZPPR-2. (4 tables) (RWR)

**29634** APPROXIMATE METHODS OF RADIATION TRANSFER THEORY. Khudyaev, S. I. Zh. Vychisl. Mat. i Mat. Fiz.; 15: No. 2, 412-428(1975). (In Russian).

Approximate analytical calculational methods related to the Wiener–Hopf integral equation are presented. These equations arise in problems of astrophysics, neutron transfer theory, crystallography, etc. In terms of the Laplace transform of the nucleus, an approximate formula is obtained for solving the Ambartsumyan–Chandrasekar equation, and an approximate analytical expression is found for characteristic times. From these results an approximate method for averaging superpositions is derived, which can be used in other problems. Direct methods are given for obtaining asymptotic solutions at infinity when roots of the typical equation are absent. (tr-auth)

**29635** PROBABILITY OF NEUTRON ABSORPTION IN PLANE AND SPHERICAL BLOCKS. Gorelov, V. P.; Il'in, V. I.; Povyshev, V. M. Zh. Vychisl. Mat. i Mat. Fiz.; 15: No. 2, 391-403 (1975). (In Russian).

A solution is presented for the neutron transfer equation using Keyes' method without dispersion to the central part of a plane and spherical systems. Within the layer neutron multiplication is considered. The probability of absorption is calculated as a function of the size of the block absorber and the properties of the surrounding medium and the effective boundary conditions on the absorber surface. The problem is examined in a single-velocity approximation. (tr-auth)

**29636** PROBLEM OF ABSORPTION COEFFICIENT OF ULTRA-COLD NEUTRONS IN MEDIUM BOUNDED BY ROUGH SURFACE. Stepanov, A. V. (Moscow State Univ.). Teor. Mat. Fiz.; 22: No. 3, 425-430(Mar 1975). (In Russian).

Absorption of ultra-cold neutrons by the trap walls is considered with taking into account the nonsmooth character of the boundary vacuum–medium. In the framework of the point scatterer model, imitating a separate nonsmooth piece of the surface, it is shown that the deviation of the boundary surface from an ideal form leads to decreasing of the absorption coefficient W of the ultra-cold neutrons. The correction $\Delta W/W_{ideal}$ in practically interesting cases is one of the order of several percents. (auth)

**29637** EXISTENCE OF THE SCATTERING MATRIX FOR THE LINEARIZED BOLTZMANN EQUATION. Simon, B. (Princeton Univ., N. J. (USA). Dept. of Physics; Princeton Univ., N. J. (USA). Dept. of Mathematics). Commun. Math. Phys.; 41: No. 2, 99-108(Apr 1975).

Following Hejtmanek, neutrons are considered in infinite space obeying a linearized Boltzmann equation describing their interaction with matter in some compact set D. The existence of the S-matrix and subcriticality of the dynamics in the (weak-coupling) case where the mean free path is larger than the diameter of D uniform in the velocity. The existence of the S-matrix also for the case where D is convex and filled with uniformly absorbent material is proven. An explicit example is presented where the dynamics is not invertible on $L^{+1}$, the cone of positive elements in $L^1$. (auth)

**29638** PERFORMANCE AND COMPARISON OF $S_N$ COMPUTER PROGRAMS. I. A Comparison of ANISN and SABINE Shielding Calculations. Donnelly, I. J. (Australian Atomic Energy Commission, Lucas Heights); Ponti, C.; Mennig, J.; Halin, C.; Lori, C.; Asaoka, T.; Pallas, V.; Herrnberger. (Australian Atomic Energy Commission, Lucas Heights). Newsl. ENEA Comput. Programme Libr.; No. 18, 5-23(Apr 1975).

A brief comparison of performances for $S_N$ computer codes is presented. Included are evaluations of ANISN and SABINE shielding calculations, comparison of analytical $S_N$ and discrete power series S calculations with ANISN, and course-mesh rebalancing acceleration for eigenvalue problems. Short descriptions ANISN-EIR and PALLAS codes are provided. (SDF)

**29639** OPERATING EXPERIENCES ON CODE UTILIZATION. Palmiotti; Salvatores; Engle, W. W. Jr. (CNEN, Italy). Newsl. ENEA Comput. Programme Libr.; No. 18, 25-30(Apr 1975).

Two cases of problems encountered in operating experience using the code ANISN in neutron transport calculations are discussed. Two cases are also considered for the code $MC^2$. Circumstances and diagnosis are stated for each case. (SDF)

**29640** ANALYTICAL SOLUTIONS OF THE TWO--VECTOR BOLTZMANN EQUATION IN NONPLANAR GEOMETRIES. Hsu, M. T. College Park, MD; Univ. of Maryland (1974). 137p. University Microfilms Order No. 75-15,777.

Thesis (Ph. D.).

Analytical solutions to the two-group neutron transport equation are obtained in one-dimensional spherical and cylindrical geometries, utilizing a procedure which transforms the integral form of the transport equation into an integro-differential equation which is amenable to solutions using Case's singular eigenfunction expansion method. The explicit form of the two-group integral equation in two-region spheres is developed. The generalized equation is then reduced to the specific formulation for single region spheres and the spherical Milne problem. The transform procedure is applied to the single region form which yields the integro-differential equation found in slab geometry. The known eigenfunctions and their properties are utilized to solve the infinite medium spherical Green's function problem. The detailed derivation of the transform procedure in two-group cylindrical geometry is given. The eigenfunctions associated with this transform equation are solved for and are shown to be related to those found in slab geometry. This fact is utilized to prove completeness of these eigenfunctions. Also, orthogonality of the eigenfunctions is demonstrated and, by extending the Poincare-Bertrand formula to incorporate multiple factors, the normalization integrals are found. Finally, the two-group infinite medium Green's function in cylindrical geometry is solved and the procedure for solving the two-group cylindrical critical problem is indicated. (Diss. Abstr. Int., B)

**29641** OPTIMUM IDEALIZATION IN FINITE-ELEMENT METHOD FOR A TWO-GROUP NEUTRON-DIFFUSION PROBLEM. Eltawila, F. M. Blacksburg, VA; Virginia Polytechnic Inst. and State Univ. (1974). 125p. University Microfilms Order No. 75-15,872.

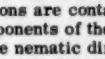
Thesis (Ph. D.).

The application of the finite-element method to the solution of the two-group neutron-diffusion equations by approximating the solution in piece-wise polynomial space is compared for different mesh sizes. The results show that the thermal flux shape is distorted and is dependent on the size of the mesh used. An algorithm based on the Fletcher and Powell optimization method is used to determine the mesh size which results in the best approximate solution. This optimum mesh selection approach permits the use of a coarse mesh, which can be refined in areas where it is needed. Numerical examples, which confirm the accuracy and demonstrate the sensitivity of the flux shape to the element size used, are presented. (auth)

**29642** SLOWING-DOWN NEUTRON SPECTRA IN SINGLE BLOCKS OF THE RESONANT ABSORBERS U, Ta, AND W. Dod, A. I.; Lysov, V. V.; Mostovoi, V. I.; Taraban'ko, V. A. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 14-22(1975). (In Russian).

The results of the measurements and calculations of slowing down spectra in highly absorbing blocks from uranium, tantalum, and tungsten surrounded by graphite moderator are given. Proposed method of the calculation of spectra satisfactorily agrees with the results of measurements by the method time of flight in the energy range of 2–200 eV. The method of measuring of slowing down resonance neutron spectrum may be recommended for verification and examination of various methods for spectra calculation and could be suitable for determination of isotopes burnup and its buildup in the blocks without their destruction and extraction from reactor. (1 table, 4 figures) (auth)

**29643** THE SELF-DIFFUSION TENSOR FOR TWO NEMATIC LIQUID CRYSTALS FROM INCOHERENT QUASI-ELASTIC NEUTRON SCATTERING AT LOW MOMENTUM TRANSFER. Leadbetter, A. J.; Temme, F. P. (Bristol Univ. (UK)); Heidemann, A.; Howells, W. S. (Institut Max von Laue – Paul Langevin, 38 – Grenoble (France)). Chem. Phys. Lett.; 34: No. 2, 363-368 (15 Jul 1975).

Theoretical results are presented for the incoherent neutron, quasi-elastic scattering law for a simple model of a liquid crystal. Experimental results are given for magnetically aligned specimens of two nematogens at low momentum transfer using a back scattering spectrometer of high energy resolution (≈ 1 μeV fwhm). It is shown that information about both rotational and translational motions are contained in the data and values are obtained for the components of the self-diffusion tensor perpendicular and parallel to the nematic director for 5 CB ($C_5H_{11}$  CN), D-5CB ($C_5D_{11}$-) and D-MBCA ($CD_3O$ CH = N CN) and the diffusion constant for the isotropic liquid phase of D-5CB. (auth)

## Nuclear Properties and Reactions, A ≤ 5

*Refer also to abstracts 29546, 29549, 29550, 30038, and 30073.*

**29644** (CONF-730750-, pp A1-A11) A–G–S FORMALISM OF THE FOUR-NUCLEON SYSTEM. Erens, G. (Univ. of South Africa, Pretoria). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

A lecture is given on how one could derive integral equations for four-nucleon systems, which are not only theoretically correct but also practically applicable, by repeated use of the Faddeev treatment of the singularities appearing in the kernel of the three-body equations. The two-, three-, and four-body cases are discussed. (JFP)

**29645** (CONF-730750-, pp B1-B15) DEUTERON WAVE FUNCTION AND THE SENSITIVITY OF THE BINDING ENERGIES OF THE TRITON AND NUCLEAR MATTER TO THE PHASE SHIFT AT HIGH ENERGIES. Fiedeldey, H. (Univ. of South Africa, Pretoria). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

The treatment covers the inverse scattering formalism, potentials fully determined by the on-shell data and the deuteron

wave function, and sensitivity to the high energy phase shift. (JFP)

**29646** (CONF-730750-, pp C1-C12) REALISTIC NONLOCAL POTENTIALS FOR TRITON CALCULATIONS. McGurk, N. J. (Univ. of South Africa, Pretoria); Fiedeldey, H.; de Groot, H.; Boersma, H.; van Wageningen, R. Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

The treatment of realistic nonlocal potentials for triton calculations covers a solution to inverse scattering problem in coupled waves and results for the triton binding energy given for the potentials discussed as well as for the Reid potential. (JFP)

**29647** (CONF-730750-, pp D1-D14) TRITON GROUND-STATE ENERGY FOR REID'S SOFT-CORE NUCLEON-NUCLEON INTERACTION. Bruinsma, J.; van Wageningen, R. (Vrije Univ., Amsterdam). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

A calculation of the ground state energy of the triton reported for the Reid soft-core nucleon-nucleon interaction is discussed covering the Reid potential, the method of the hyperspherical function basis, and the results for the triton ground-state energy. (JFP)

**29648** (INIS-mf-1719) BASIC STATE AND FORM FACTORS OF $^3$H AND $^3$He. Yamaoka, R. (Instituto de Fisica Teorica, Sao Paulo (Brazil)). 1973. 62p. (In Portuguese). INIS.

The objective is to calculate the binding energy and the charge form factor of tritium and helium-3, using the variational method. The test wave functions is expanded in terms of harmonic oscillator functions. Then the construction of complete systems of translationally invariant states for three nuclei using auto-functions of harmonic oscillator is discussed. (auth)

**29649** (INIS-mf-1725) APPLICATION OF THE BASIC APPROXIMATION OF THE K-HARMONICS METHOD TO THE ALPHA PARTICLE. Escobar, B. M. P. (Instituto de Fisica Teorica, Sao Paulo (Brazil)). 1973. 56p. (In Portuguese). INIS.

The basic approximation of the K-harmonics method is applied to obtain a wave function of the ground state of the alpha particle, as well as its binding energy, its average square charge radius, and its charge form factor for different potentials. A summary of the method is made, establishing the notation and presenting the formulas to be used. The method is then applied to the ground state of the alpha particle, and the form factor is studied. Finally, an analysis is given of the results obtained. (auth)

**29650** (JINR-E1-9048) $\pi^3$He$^3$H COUPLING CONSTANT ESTIMATION USING THE CHEW-LOW EQUATION. Mach, R.; Nichitiu, F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1975. 20p. Dep. NTIS (US Sales Only) $4.00.

An estimation of the $\pi$He$^3$H$^3$ coupling constant is made using the Chew-Low equation and a semi-phenomenological analysis is given of the $\pi^3$He$^3$ elastic differential cross sections at 98, 120, 135, and 156 MeV. (auth)

**29651** (JINR-E-4-8200) OPTICAL MODEL ANALYSIS OF PION ELASTIC SCATTERING BY $^3$He. Mach, R.; Nichitiu, F.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 10p. INIS.

10 refs.; 2 figs.; submitted to Physics Letters.

Within the framework of the theory of multiple scattering, a first-order optical scattering is obtained. The potential contains spin and isospin terms and terms due to inclusion of Fermi movement. Calculations for the optical model of elastic scattering of pions are made for the He nucleus at 97 and 154 MeV. Calculated and experimental data are compared. Calculations presented for the effective cross sections for $\pi^+$ meson reactions agree well with experimental data. The different behavior of the effective cross section of $\pi^+$ and $\pi^-$ meson elastic scattering is explained. (tr-auth)

**29652** (JINR-R-2-7871) SPACE-TIME DEVELOPMENT OF THE HADRON MULTIPLE PRODUCTION AND THE MECHANISM OF THE TOTAL NUCLEAR DISINTEGRATION. Kalinkin, B. N.; Shmonin, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 20p. (In Russian). INIS.

Analysis of the passage of hadron klastrons through the nucleus shows that they can initiate its "complete" destruction. (tr-auth)

**29653** (JINR-R-7-7915) ON NON-EQUILIBRIUM PROCESSES IN MULTI-NUCLEON TRANSFER REACTIONS. Gudima, K. K.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 9p. (In Russian). INIS.

9 refs.; 1 fig.; submitted to Physics Letters.

The dependence of isotope yield in multi-nucleon transfer from Q values for ground states of nuclei observed experimentally may be explained without inclusion of the compound nucleus concept. Comparison with experimental data indicates the substantial role of nonequilibrium processes in the reaction considered. (tr-auth)

**29654** (LBL-4087) POLARIZATION SYMMETRIES IN DIRECT REACTIONS: $^3$He(t vector, d)$^4$He AND $^2$H(d vector, p)$^3$H. Conzett, H. E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 7p. (CONF-750829-4). Dep. NTIS $4.00.

From 4th international symposium on polarization phenomena in nuclear reactions; Zurich, Switzerland (25 Aug 1975).

It is shown that if the a'(a(pol),c)d reaction mechanism is a purely direct transfer process, then a symmetry condition imposed on the analyzing powers becomes a clear signature of the direct transfer mechanism as contrasted with the compound-nucleus process. No such information is available from cross section data alone. As examples, the reactions $^3$He(t(pol),d)$^4$He and $^3$H(d(pol)p)$^3$H are considered. (3 figures) (SDF)

**29655** (LBL-4096) ANALYSIS OF REACTIONS INDUCED BY POLARIZED PARTICLES. Seiler, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 7p. (CONF-750829-5). Dep. NTIS $4.00.

From fourth international symposium on polarization phenomena in nuclear reactions; Zurich, Switzerland (25 Aug 1975).

The analysis of reactions induced by polarized particles is discussed, focusing on the problem of finding those amplitudes which are responsible for the major structures of the observables as a function of energy and angle. Examples of the methods outlined are given for $^3$He(d,p)$^4$He and $^3$H(p,n)$^3$He. (5 figures) (SDF)

**29656** A-DEPENDENCE OF HIGH-ENERGY INELASTIC ELECTRON-NUCLEUS SCATTERING. Ditzler, W. R.; Breidenbach, M.; Friedman, J. I.; Kendall, H. W.; Poucher, J. S. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science); Bloom, E. D.; Cottrell, R. L. A.; Coward, D. H.; DeStaebler, H.; Jordan, C. L. Phys. Lett., B; 57: No. 2, 201-204 (23 Jun 1975).

Cross sections for inclusive inelastic electron scattering from H, D, Be, Al, Cu and Au have been measured at 6° for incident energies up to 19.5 GeV. Within the stated errors, the cross sections were found to be directly proportional to the sum of the constituent nucleon cross sections. (auth)

**29657** MEASUREMENTS OF PROTON-PROTON DIFFERENTIAL CROSS SECTIONS AT 5, 7 AND 8 MeV. Imai, K.; Nisimura, K.; Tamura, N. (Kyoto Univ. (Japan). Dept. of Physics); Sato, H. (National Laboratory for High Energy Physics, Tsukuba, Japan). Nucl. Phys., A; 246: No. 1, 76-92(14 Jul 1975).

The p-p differential cross sections at 5, 7 and 8 MeV have been measured with accuracies of $\pm 0.3\%$ relative and $\pm 0.4\%$ absolute. The central P-wave phase-shift combination, $^3\Delta_c$, and the S-wave phase shifts have been determined by a phase-shift analysis of these data and compared with other analyses. (auth)

**29658** PHASE-SHIFT ANALYSIS OF SPIN-CORRELATION COEFFICIENTS IN p-d SCATTERING: A SOLUTION TO THE $^2$S DEFECT. Chauvin, J.; Arvieux, J. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). Nucl. Phys., A; 247: No. 2, 347-358(4 Aug 1975).

A phase-shift analysis of combined cross-section and spin-correlation data has been performed for the elastic scattering of protons by deuterons. Reliable doublet phases have been extracted and compared with extensive Faddeev-type calculations using different rank-one separable interactions. The effect of P-wave N-N forces is discussed and intrinsic strengths and range are deduced. (auth)

**29659** MEASUREMENTS OF THE SPIN-CORRELATION COEFFICIENTS $C_{xx}$, $C_{yy}$ AND S FOR d-p SCATTERING AT $E_d$ = 17.4, 19.5, 23.8, AND 26.1 MeV. Chauvin, J.; Garreta, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)), Fruneau, M. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). Nucl. Phys., A; 247: No. 2, 335-346 (4 Aug 1975).

The spin-correlation coefficients $C_{xx}$, $C_{yy}$ and S have been measured by scattering the vector- and tensor-polarized deuteron beam of the Grenoble cyclotron from a polarized proton target. Comparison is made with Faddeev equation calculations using a separable N-N interaction. The results are in good agreement only when P-waves and the tensor force are taken into account in the N-N interaction. (auth)

**29660** NEUTRON-PROTON FINAL STATE INTERACTION IN THE $^3$H($^3$He,p$\alpha$)n REACTION AT LOW BOMBARDING ENERGIES. Schrieder, G.; Genz,H ; Richter, A. (Bochum Univ. (F. R. Ger-

many). Inst. fuer Experimentalphysik); von Witsch, W. (Bonn Univ. (F. R. Germany). Inst. fuer Strahlen- und Kernphysik). Nucl. Phys., A; 247: No. 2, 203-210(4 Aug 1975).

The $^3H(^3He,p\alpha)n$ reaction has been studied in a kinematically complete experiment at $^3He$ bombarding energies between 0.31 and 2.80 MeV in order to detect a possible resonant energy dependence of the spin singlet (T = 1) neutron-proton final-state interaction (FSI). The data in the region of low n-p relative energies have been analyzed in terms of the Watson-Migdal formalism. Only a slight relative increase of the $^1S_0$ n-p FSI is observed with increasing bombarding energy. This result is not easily related to the strong isospin violations found in the two-body reaction $^3H(^3He,d)^4He$ at similar $^3He$ energies. (auth)

**29661** BOUND STATES OF $^3H$ AND $^3He$ WITH THE REID POTENTIAL. Hennell, M. A.; Delves, L. M. (Liverpool Univ. (UK)). Nucl. Phys., A; 246: No. 2, 490-504(21 Jul 1975).

A calculation of the bound-state parameters of $^3H$ and $^3He$ with the soft-core Reid potential is described, and a comparison is given with the results of other authors for this system. (auth)

**29662** ANGULAR DISTRIBUTIONS OF NEUTRONS FROM THE $^3H(d,n)^4He$ REACTION. Magiera, E.; Bormann, M.; Scobel, W. (Hamburg Univ. (F. R. Germany). 1. Inst. fuer Experimentalphysik); Heiss, P. (Koeln Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Nucl. Phys., A; 246: No. 2, 413-424 (21 Jul 1975).

Angular distributions of the $^3H(d,n)^4He$ neutron source reaction have been measured with a recoil proton detector for deuteron energies from 8 MeV to 16 MeV in 1 MeV steps. The relative distributions are related by means of an excitation function taken at zero degrees. The results are compared with recent data obtained with time-of-flight techniques. Calculations with phase shifts from the refined cluster model were performed, which included partial waves up to l = 3 and the two-particle channels $^3H + d$, $n + {}^4He$ and $n + {}^4He^*$. They show remarkable agreement with the experimental angular distributions both in shape and in absolute magnitude. (auth)

**29663** APPLICATION OF THE IMPROVED METHOD OF MOMENTS TO THE SOLUTION OF THREE-BODY SCATTERING PROBLEMS. Harms, E. (Fairfield Univ., Conn. (USA)). Nucl. Phys., A; 247: No. 1, 51-58(28 Jul 1975).

The improved method-of-moments procedure, which was developed in an earlier paper, is applied to the solution of the three-body scattering equations for separable two-body interactions. Results of these calculations further support conclusions reached previously that the improved method of moments provides a rapid and accurate calculational procedure for solving scattering problems. (auth)

**29664** BREAK-UP REACTION $^2H(p,2p)n$ AT 8.5 MeV. Kuehn, B.; Kumpf, H.; Moesner, J.; Neubert, W.; Schmidt, G. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Nucl. Phys. A; 247: No. 1, 21-42(28 Jul 1975).

Differential cross sections have been measured for the $^2H(p,2p)n$ reaction in a kinematically complete experiment. The results are compared with calculations performed with a program based on the Ebenhoh code. The code includes Coulomb repulsion in a approximate way and is used with six different S-wave separable potentials. The calculations fit the experimental data with differing degrees of success. Systematic deviations occur mainly at the n-p final-state interaction peaks. It is concluded that new information about the N-N interaction can be obtained from break-up data if improved theoretical calculations are feasible. (auth)

**29665** SCATTERING OF 31.5 MeV POLARIZED $^3He$ BY PROTONS. Blyth, C. O.; Karban, O.; Powell, W. B.; Roman, S. (Birmingham Univ. (UK). Dept. of Physics). Nucl. Phys., A; 247: No. 1, 1-6(28 Jul 1975).

The angular distribution of $^3He$ polarization was measured in the scattering of a polarized $^3He$ beam by protons at a mid-target energy of 31.5 MeV. The results together with the available cross section and proton polarization data were analyzed in terms of phase shifts and mixing parameters. The measured left-right asymmetry of recoil protons was used in the design of a $^3He$ polarimeter. (auth)

**29666** RELATION BETWEEN NON-SINGULAR THREE-PARTICLE EQUATIONS. Fuda, M. G. (State Univ. of New York, Buffalo (USA). Dept. of Physics). Nucl. Phys., A; 245: No. 3, 461-465(7 Jul 1975).

The relationship between the equations obtained by applying Kowalski's generalized Sasakawa method to the three-body problem and those obtained from the author's extension of the Sasakawa method to the three-body problem is illustrated by means of an example. It is shown that the approximate scattering amplitudes obtained by iterating the author's equations satisfy unitarity below the breakup threshold. A suggestion is made for accelerating the convergence of the iterative solution of Kowalski's equations. (auth)

**29667** PHOTODISINTEGRATION OF $^3He$. Hendry, J. M.; Macleod, A. M. (Univ. of Glasgow). J. Phys., G (London); 1: No. 5, 528-533(20 Jun 1975).

The photodisintegration of $^3He$ has been studied using a cloud chamber with emphasis on the comparison of the mechanism of the three-body reaction with the theory of Barbour and Phillips. Relative yields in two and three-body channels are consistent with theory and the experimental work of Fetisov et al. Differences are observed however from theory in the emphasis on the proton-proton and proton-neutron correlation in the final state interaction of the three-body channel. (auth)

**29668** COULOMB DIFFERENCE FOR VERTEX FUNCTIONS FOR THE VIRTUAL DECAYS $^3H \rightarrow D + N$ AND $^3He \rightarrow D + P$. Sergeev, V. A. (Inst. for Nuclear Studies, Moscow). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 82-86(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2557-2561 (1974).

Estimates of the vertex ratio for the decay of $^3He$ and $^3H$ are obtained within the framework of a simple model in which the wave function for the relative motion of the nucleons and the deuteron is determined by an effective rectangular potential. The resulting estimate is used to calculate the cross section ratio for the direct reactions $^2H(dn)\,^3He$ and $^2H(dp)^3H$. (SDF)

**29669** ELASTIC SCATTERING OF ALPHA PARTICLES BY $^6Li$ AND THE SPIN-ORBITAL POTENTIAL. Gridnev, K. A.; Kangropol, Yu. V. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 66-68(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2539-2542(1974).

It is shown that large-angle scattering of alpha particles by $^6Li$ can be described with the aid of the spin-orbital potential $(\vec{l}\vec{L})$, where $\vec{l}$ is the spin of the target nucleus. The constant in front of the spin-orbital term is estimated and the role of the imaginary part of the spin-orbital potential is evaluated. (3 figures) (auth)

**29670** APPROACHES TO THE INTERPRETATION OF HEAVY ION TRANSFER REACTIONS AT HIGH ENERGIES. Buck, B. (Oxford Univ. (UK). Dept. of Theoretical Physics). pp 152-164 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

Various theoretical approaches to the interpretation of recent transfer experiments on light nuclei are outlined. Starting from some simple ideas on the reaction mechanism the observed highly selective nature of the reactions is discussed successively in terms of j-j coupled nucleon configurations, more sophisticated shell models of the SU3 type and, finally, as possible evidence for cluster correlations in nuclei. (auth)

**29671** ELECTRONS SCATTERED FROM HELIUM BELOW 5.0 eV. Tsung, P. N. (Cincinnati Univ., Ohio (USA). Dept. of Physics). Physica; 79: No. 5, 520-528(1975).

An observation of a low-energy helium scattering peak from the scattering of electrons is made by using three identical 127 deg cylindrical electrostatic spectrometers. A sharp peak is observed after electron impact on helium gas as the nominal incident electron energy is varied from 0.0 to 5.10 eV, and is seen in the scattering-angle range of 10 to 45 deg. The maximum scattering peak occurs at about 1.6 eV incident energy. The properties of the helium peak investigated and evidence for its reality are given. (auth)

**29672** DISCREPANCY IN THE DOUBLY RADIATIVE NEUTRON-PROTON CAPTURE. Hyuga, H.; Gari, M. (Bochum Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Phys. Lett., B; 57: No. 4, 330-334(21 Jul 1975).

The theoretical cross section for the doubly radiative n-p capture at thermal energies is reinvestigated. The upper limit of the ratio R of the two-photon emission cross section to the one photon emission cross section is found to be $R \leq 10^{-7}$. This limit is 3 orders of magnitudes larger than a previous calculation, however, still four orders of magnitudes too small compared to a recent experiment which thus remains to be explained. (auth)

**29673** ESTIMATION OF THE COUPLING $^4He\,dd$. Dubnicka, S. (Joint Inst. for Nuclear Research, Dubna (USSR)); Dumbrajs, O.

(Warsaw Univ. (Poland). Instytut Fizyki Teoretyczne)). Phys. Lett., B; 57: No. 4, 327-329(21 Jul 1975).

The estimate of the coupling $^4$He dd was obtained. The method is based on the extrapolation of $d\sigma/d\Omega$ to the deuteron pole, exploiting conformal mapping with a special trick to avoid complications due to electromagnetic contamination of data. (auth)

**29674** ANALYTICITY IN HADRON-NUCLEI BINARY REACTIONS. Dubnicka, S.; Dumbrajs, O. (Joint Inst. for Nuclear Research, Dubna (USSR)). Phys. Rep.; 19: No. 3, 141-168(Jul 1975).

The practical use of the hypothesis analyticity in hadron scattering on light nuclei is considered. A method for determination of locations of nearest singularities of the hadron–nuclei binary reaction amplitudes by means of Feynman diagrams is described. The experimental data on real parts of the forward hadron–nuclei scattering amplitudes are compiled. The existing evaluations of the forward dispersion relations are reviewed. The description of exploitation of analyticity of scattering amplitude in the cos $\psi$-plane for extraction of information about coupling constants (spectroscopic factors) by means of analytic extrapolation is given. (auth)

# Nuclear Properties and Reactions, 6 ≤ A ≤ 19

*Refer also to abstracts 29369, 29656, 29670, 29674, 29741, 29906, 29958, 29959, and 29961.*

**29675** (BNL-20351) BNL MULTIPARTICLE SPECTROMETER (MPS) PROGRAM. Love, W. A. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 21p. (CONF-750729-2). Dep. NTIS $4.25.

From new directions in hadron spectroscopy meeting; Argonne, Illinois, USA (7 Jul 1975).

Data were recorded for $\bar{p}p$ interactions at 3.7 to 4.2 GeV/c. The missing-mass squared spectrum for LAMBDA events is shown. The various detectors used or planned are discussed. (JFP)

**29676** (JINR-1-7894) ISOTOPIC EFFECTS IN INELASTIC INTERACTIONS OF 660 MeV PROTONS WITH THE $^{10}$B AND $^{11}$B NUCLEI. Avdeichikov, V. V.; Bogatin, V. I.; Grigor'ev, E. L.; Lozhkin, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 18p. (In Russian). INIS.

Effects related to the number of neutrons in the nuclear targets were studied experimentally for the interaction of 660-MeV protons with $^{10}$B and $^{11}$B. There were differences in the absolute cross-sections of formation of the isotopes $^{1,2,3}$H and $^{3,4}$He from the two B isotopes and in the shape of the spectrum of $^3$He and $^4$He emitted by the B. The ratio of the cross-section of formation of H and He from $^{10}$B and $^{11}$B showed a strong correlation with the isotopic spin of the secondary particles. (tr-auth)

**29677** (JINR-E1-8935) QUASIELASTIC SCATTERING OF 670 MeV PROTONS ON DEUTERON CLUSTERS IN $^6$Li AND $^7$Li NUCLEI (PRELIMINARY RESULTS). Albrecht, D.; Chemnitz, G.; Eroe, J. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 15p. Dep. NTIS (US Sales Only) $4.00.

Kinematically complete measurements of quasielastic scattering of 670 MeV protons on deuteron clusters in $^6$Li and $^7$Li nuclei have been made at an angle of 165° c.m.c. In the $^6$Li(p,pd)$^4$He reaction the alpha particle is produced mostly in the ground state. For the $^7$Li(p,pd)$^5$He reaction those events are more probable when the residual nucleus is produced in the excited state. The half width of intranuclear momentum distribution of deuteron clusters has been determined and is approximately 100 MeV/c for $^6$Li and approximately 130 MeV/c for $^7$Li. (4 figures) (auth)

**29678** (JINR-R-15-8217) STUDY ON THE $^{14}$N($^3$He,p)$^{16}$O REACTION. Osetinskii, G. M.; Semenov, V. M.; Son Von Nam; Faruk, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 24p. (In Russian). INIS.

Differential cross sections were measured for the reaction $^{14}$N($^3$He,p)$^{16}$O for the groups $p_{1,2}$, $p_3$; $p_{4,5}$, $p_7$ in the energy range 2.0 to 4.0 MeV at angles of 45, 90, and 135°. The angular dispersions of the same groups of protons were measured at angles of 2 to 165°. The possibility was considered of describing the results by a Born approximation with distortion by the waves upon consideration of the mechanism of the compound nucleus by the Hauser–Feschbach method. The application of a model of shells with residual forces for spectroscopic calculations of the activated state of $^{16}$O was studied. (tr-auth)

**29679** COUPLED CHANNELS TREATMENT OF TRANSFER REACTIONS. Cotanch, S. R. (Pittsburgh Univ., Pa. (USA). Dept. of Physics). Phys. Lett., B; 57: No. 2, 123-126(23 Jun 1975).

Consistent coupled channels calculations, using folded optical potentials, are performed by iteration for the reactions $^{15}$O(d,d), $^{16}$O(d,p), and $^{17}$O(p,p). The kernel is greatly changed when the nonorthogonality of the channel wave functions is included. The nonorthogonality corrections tend to cancel the effects from higher-order processes except for $^{17}$O(p,p) where only higher-order processes are important. The use of folded potentials reduces both effects. (auth)

**29680** MAGNETIC MOMENT OF THE FIRST-EXCITED $2^+$ STATE IN $^{18}$O. Speidel, K. H.; Goldberg, M. B.; Hagemeyer, K.; Kumbartzki, G. J. (Bonn Univ. (F. R. Germany). Inst. fuer Strahlen- und Kernphysik); Goldring, G.; Shkedi, Z. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics); Schramm, M. (Koeln Univ. (F. R. Germany). 1. Physikalisches Inst.); Doubt, H. A. (Rijksuniversiteit Utrecht (Netherlands). Fysisch Lab.). Phys. Lett., B; 57: No. 2, 143-146(23 Jun 1975).

The magnetic decoupling method, applied to highly ionized nuclear-excited $^{18}$O atoms, has yielded for the 198 MeV $2^+$ state the value $g = 0.35 \pm 0.04$. In conjunction with the recently determined negative sign, this value agrees well with weak j-j coupling predictions. (auth)

**29681** SUPERALLOWED $\beta$-DECAY OF $^{18}$Ne, $^{22}$Mg AND $^{26}$Si. Hardy, J. C.; Schmeing, H.; Geiger, J. S.; Graham, R. L. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Nucl. Phys., A; 246: No. 1, 61-75(14 Jul 1975).

The decays of $^{18}$Ne, $^{22}$Mg and $^{26}$Si have been studied in experiments that employed a gas-transport system to reduce background activities. Through observation of the spectra of $\beta$-delayed $\gamma$-rays, the half-lives of the three nuclei were measured to be 1687 ± 9, 3857 ± 9, and 2210 ± 21 ms, respectively, and the branching ratios of the respective superallowed transitions were determined to be (7.66 ± 0.21), (54.0 ± 1.1) and (74.9 ± 0.9)%. The resulting ft values give no indication of significant charge-dependent mixing, and comparison with the decay of $^{26m}$Al yields a mirror asymmetry for mass 26 of $\Delta = (-0.8 \pm 1.5)\%$. These results are consistent with expectations. In addition, the ft values for a number of Gamow-Teller transitions have been established. (auth)

**29682** $^{11}$B($\alpha$,n)$^{14}$N CROSS SECTION FOR $\alpha$-ENERGIES UP TO 8 MeV. Van der Zwan, L.; Geiger, K. W. (National Research Council of Canada, Ottawa, Ontario. Div. of Physics). Nucl. Phys., A; 246: No. 1, 93-103(14 Jul 1975).

The three neutron groups, populating the ground state, the 2.313 and the 3.945 MeV states of $^{14}$N were studied. More than 30 resonances were seen in the 0° excitation curve. Angular distributions were taken at 58 $\alpha$-energies, between 3.7 and 7.9 MeV. Neutron production cross sections, derived from these distributions were compared by the method of detailed balance to the previously known $^{14}$N(n,$\alpha$)$^{11}$B cross section. Compound nucleus formation involving overlap of several resonances appears dominant for the emission of all three neutron groups. (auth)

**29683** MICROSCOPIC ANALYSES OF PROTON INELASTIC SCATTERING BY $^{16}$O AND $^{40}$Ca USING A COMPLEX T-MATRIX. Geramb, H. V. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik); Hodgson, P. E. (Oxford Univ. (UK). Nuclear Physics Lab.). Nucl. Phys., A; 246: No. 1, 173-186(14 Jul 1975).

A microscopic distorted wave analysis is made of proton inelastic scattering to the $3_1$-states of $^{16}$O and $^{40}$Ca and the $5_1$-state of $^{40}$Ca. The transition is caused by the long-range part of the Hamada–Johnston interaction, as the real effective two-nucleon interaction, supplemented by a phenomenological complex single-particle potential to account for higher order processes. The differential cross sections from 25 to 61 MeV are well reproduced and the complex single-particle transition potential is numerically determined to be smoothly energy dependent, predominantly imaginary and to resemble the first derivative of the imaginary part of the optical model. (auth)

**29684** $^{15}$N(e,$p_0$)e'$^{14}$C CROSS SECTIONS BETWEEN 14 AND 28 MeV EXCITATION ENERGY. Murphy, J. J. II; Shin, Y. M.; Skopik, D. M. (Saskatchewan Univ., Saskatoon (Canada). Saskatchewan Accelerator Lab.). Nucl. Phys., A; 246: No. 1, 221-230(14 Jul 1975).

The electrodisintegration cross section for the reaction $^{15}$N(e,$p_0$)e'$^{14}$C was measured and converted to the corresponding photodisintegration cross section at five angles. Results for the differential and total cross sections are given for excitation energies between 14 and 28 MeV. The Legendre coefficients of the angular distributions indicate not only the dominance of the E1 excitation but also the presence of higher multipole excitations in the energy region studied. This work is compared to older photodisintegration measurements and to more recent proton capture experiments. (auth)

**29685** RECOIL-DISTANCE LIFETIME MEASUREMENTS OF LOW-LYING STATES OF $^{21}$Ne, $^{24}$Na, $^{25}$Mg AND $^{42}$K WITH THE B+ $^{16}$O AND $^{26}$Mg+ $^{18}$O REACTIONS. Eggenhuisen, H. H.; Engelbertink, G. A. P.; Mondria, J.; van Driel, M. A.; Hermans, J. A. J. (Rijksuniversiteit Utrecht (Netherlands). Fysisch Lab.); Ekstroem, L. P. (Lund Univ. (Sweden)). Nucl. Phys., A; 246: No. 1, 231-245(14 Jul 1975).

The recoil-distance method has been used in conjunction with the B+$^{16}$O and $^{26}$Mg+$^{18}$O reactions to measure mean lives of low-lying states of $^{21}$Ne, $^{24}$Na, $^{25}$Mg and $^{42}$K. The following results are obtained: $^{21}$Ne, $E_\gamma$ = 0.35 MeV, $\tau_m$ = 12.9 ± 1.6 ps; $^{24}$Na, 0.56 MeV, 46 ± 6 ps; $^{25}$Mg, 0.97 MeV, 16.9 ± 1.0 ps; $^{42}$K, 0.11 MeV, 410 ± 60 ps; 0.26 Mev, 192 ± 13 ps; 0.70 MeV, 59 ± 11 ps and 1.38 MeV, 1690 ± 120 ps. Excitation energies and branching ratios for $^{42}$K levels are given. Combination of $\gamma$-$\gamma$ coincidences on 2 ns delayed $\gamma$-rays and the recoil-distance data establish a hitherto unobserved $^{42}$K level at an excitation energy of 1375.5 ± 0.2 keV. This level, which decays exclusively to the 699 keV, $J^\pi$ = (5)$^-$ level, is tentatively assigned the stretched isospin configuration $\{(1d^{5}_{/2}{}^{-2})_{01}(1f^{1}_{/2}{}^{4})_{6+}, 1\}$ 6+,2. A calculation with a weak-coupling model supports this assignment. (auth)

**29686** CONNECTED KERNEL METHODS IN NUCLEAR REACTIONS. I. Derivation of the Connected Kernel Equations. Redish, E. F. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Service de Physique Theorique). Nucl. Phys., A; 225: No. 1, 16-36(4 Jun 1974).

A set of connected kernel equations for the scattering operator are derived. The equations connect only the two cluster channels and generalize the equations of Lovelace (for N = 3) and Sloan (for N = 4) to arbitrary N. This is done by summing all disconnected diagrams explicitly by induction. Methods for handling multiple summations over partitions are developed and presented. The resulting equations are similar to those given by Bencze but have a different Born term. An error in Bencze's derivation is pointed out but it is shown that only the two cluster connected part of the Born term contributes on-shell so his final equation is correct and equivalent to the author's. (auth)

**29687** RECOIL DISTANCE LIFETIME MEASUREMENTS OF THE LOWEST 2$^+$ AND 4$^+$ STATES OF $^{18}$O. Berant, Z.; Broude, C.; Engler, G.; Start, D. F. H. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Physics). Nucl. Phys., A; 225: No. 1, 55-60(4 Jun 1974).

Using the recoil-distance method, mean lives of 3.58 ± 0.18 ps and 24.8 ± 1.3 ps have been measured for the 1.98 MeV, 2$^+$ and 3.56 MeV, 4$^+$ states in $^{18}$O, using the reaction $^{16}$O($\alpha$,$\alpha'$) at $E_\alpha$ = 6.0 and 8.5 MeV. (auth)

**29688** FT VALUE OF THE $^{10}$C SUPERALLOWED FERMI $\beta$-DECAY. Robinson, D. C. (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences); Barker, P. H. (Auckland Univ. (New Zealand). Dept. of Physics). Nucl. Phys., A; 225: No. 1, 109-118(4 Jun 1974).

The total half-life for the decay of $^{10}$C to states in $^{10}$B has been determined together with the threshold for the $^{10}$B(p,n)$^{10}$C reaction. Results were $T_{\frac{1}{2}}$ = 19.151 ± 0.026 sec and $E_p$ = 4880.0 ± 0.6 keV respectively. When averaged with a previous threshold measurement, they led to an ft value of 3112 ± 31 sec for the pure Fermi decay after radiative corrections. (auth)

**29689** EXPERIMENTAL INVESTIGATION OF MULTIPLE SCATTERING OF 50 MeV ELECTRONS. Aleksandrov, Yu. M.; Grushin, V. F.; Zinevich, A. N.; Dzhilayan, L. Z.; Oboznyi, V. A. (Inst. of Nuclear Research, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1597-1600(May 1975). (In Russian).

The angular distributions of electrons scattered by thin Be, Nb and Ta foils are measured. The experimental results can satisfactorily be described by a Gaussian function $\exp(-\theta^2/\theta^2 w)$. Values of the parameter thus obtained are compared with predictions of the Moliere theory in the form $\theta w = \theta_1(B - X)^{\frac{1}{2}}$ proposed by Hanson et al. who employed X = 1.2. The value of X is estimated to be 0.82 ± 0.19. (auth)

**29690** alpha PARTICLE MODEL OF $^{16}$O. Poon, B. W. East Lansing, MI; Michigan State University (1975). 84p. University Microfilms Order No. 75-14,808.

Thesis (Ph. D.).

The low lying even parity states of $^{16}$O are investigated by the coupled-channel method in the weak-coupling model of the alpha particle and $^{12}$C nucleus. Different phenomenological alpha-alpha potentials are used in determining the effective alpha-$^{12}$C potential. In calculating the effective alpha-$^{12}$C potential, no intrinsic excited states of $^{12}$C are considered, but their effects on different physical properties are calculated. The problem of wave function symmetry is considered. Correct binding energies of the bound states can only be obtained when we use a deep alpha-alpha potential. From our results we show that the alpha-alpha scattering data do not sufficiently determine the interaction to make predictions on the structure of more complicated nuclei. The interactions with repulsive cores give a very smooth structure to the states and tend to underbind the ground state. Also the transition rates to the $O_2^+$ state are too large. The deep attractive interactions suffer from opposite defects. The states are now overbound, and differ from each other to such an extent that the transition rates are an order of magnitude too small. Of the two types of interaction, we prefer the deep potential, because the structure of the states matches the more fundamental cluster model. (auth)

**29691** SURVEY OF THE ($^3$He,$^7$Be) REACTION AT 70 MeV. Steele, W. F. East Lansing, MI; Michigan State University (1974). 116p. University Microfilms Order No. 75-4,835.

Thesis (Ph. D.)

Using the 70 MeV $^3$He beam of the Michigan State University cyclotron, a study of the ($^3$He,$^7$Be) reaction has been undertaken. By surveying a wide range of target nuclides, namely $^{12,13}$C, $^{16}$O, $^{24,26}$Mg, $^{40,48}$Ca, $^{58,60,62,64}$Ni, $^{90}$Zr, $^{120,124}$Sn, $^{144}$Sm, and $^{208}$Pb, systematics of the alpha clustering phenomenon are investigated. In addition, masses and energy levels of $^{44}$Ar, $^{60}$Fe, and $^{120}$Cd are measured. In order to assure adequate resolution for a large acceptance solid angle, an Enge split pole magnetic spectrograph is used to analyze momenta of the reaction products. A single wire gas filled proportional counter measures the relative positions of the ions as they cross the magnet's focal plane. Taking advantage of the well defined time structure of the cyclotron beam, charged particle time of flight, together with the proportional counter energy signal, is used for particle identification. Despite the relatively low yield, excellent particle identification is achieved. Differential cross sections as low as 200 nb/str are successfully measured. The finite range DWBA program LOLA of R.M. DeVries has been used to calculate reaction differential cross sections for comparison to data, assuming the reaction to proceed by a direct alpha transfer mechanism. Alpha spectroscopic factors are extracted. Despite the sharp decline of peak differential cross section with increasing target mass, the corresponding spectroscopic factors remain nearly constant. Since the alpha spectroscopic factor may be taken as a measure of surface alpha cluster probability, alpha clustering appears to remain important for heavy nuclides. (auth)

**29692** COHERENT SCATTERING AND COHERENT THREE PION PRODUCTION FROM BOTH THE GROUND STATE AND THE FIRST EXCITED STATE OF CARBON AT 6 GeV/c. Wojslaw, R. J. Urbana, IL; University of Illinois (1974). 105p. University Microfilms Order No. 75-11,804.

Thesis (Ph. D.).

A study was made of the following coherent interactions on carbon nuclei at 6 GeV/c: (i) pi$^-$C yields pi$^-$C$_{4.44}$, (ii) pi$^-$C yields pi$^-$C, (iii) pC yields pC$_{4.44}$, (iv) pC yields pC, and (v) pi$^-$C yields pi$^+$pi$^-$pi$^-$C$_{4.44}$. The notation C$_{4.44}$ denotes the J/sup P/ equals 2$^+$ excited state of the carbon nucleus at 4.44 MeV. Results reported include differential cross sections, integrated cross sections, nuclear density-matrix elements, and the spin-parity composition of the 3pi system. (Diss. Abstr. Int., B)

**29693** ISOSPIN COUPLING IN (d,t) AND (d,$^3$He) REACTIONS. Datta, S. K. Chapel Hill, NC; University of North Carolina (1974). 141p. University Microfilms Order No. 75-15,629.

Thesis (Ph. D.).

The isospin-coupled Distorted-Wave-Born-Approximation (DWBA) theory for single nucleon transfer reactions is used to fit cross-section and vector-analyzing-power data obtained with 15-MeV vector-polarized deuteron beams. The reactions measured and analyzed are (d,t) and (d,$^3$He) on $^{10}$B, $^{14}$N and $^{32}$S. For l equals 0 transfers the weakly-bound-projectile-model (WBP) is discussed as an alternative to the DWBA approach and the evidence of the vector-analyzing-power data in its favor is presented. The differences between isospin-coupled DWBA and uncoupled DWBA are investigated by varying the isospin parameters and studying the sensitivity of the isospin-coupled calculations to such variations. A comparison is made between the isospin-coupled and the uncoupled theory on the basis of their agreement with experimental data. The need of making nonlocality and finite-range corrections to isospin-coupled DWBA calculations is discussed. (auth)

**29694** STATISTICAL EFFECTS IN THE INTERACTIONS OF COMPLEX NUCLEI. Shapira, D. New Haven; Yale University (1974). 234p. University Microfilms Order No. 75-15,373.

Thesis (Ph. D.).

Heavy ion scattering and reaction excitation functions in many light nuclear systems have been characterized by marked energy dependence. This energy dependence has spanned a wide range of characteristic widths; on the one hand broad structure attributable

to potential scattering has been observed and on the other much narrower structure suggestive of statistical fluctuation phenomena. In systems such as $^{16}O + ^{16}O$, $^{16}O + ^{12}C$ and $^{12}C + ^{12}C$ structure of intermediate width appears which does not fall obviously into either of these categories and a number of novel mechanisms have been suggested for its explanation. This dissertation reports on a complete examination of this situation in the $^{12}C + ^{12}C$ and $^{16}O + ^{12}C$ systems--both experimental and theoretical. Existing elastic scattering and newly measured reaction data have been subjected to a consistent statistical examination. Synthetic excitation techniques have been evolved to determine empirical corrections to the parameters extracted from such analyses to reflect the presence of non-statistical, e.g., potential scattering phenomena. Using these corrections, entirely consistent values of average widths, etc., have been obtained for all channels studied. In the $^{12}C + ^{12}C$ system it has been found possible to encompass all the non-potential structure within the framework of the statistical models without requiring recourse to any of the more specialized mechanisms. This has also been the case in the $^{12}C + ^{16}O$ system but with the striking exception of sharp resonant structure which appears to correspond to a state at 36.5 MeV in $^{28}Si$ having J equals 14 and GAMMA equals 400 keV. Considerable effort has been devoted to elucidating the structure of the state since it appears to open up an entirely new class of nuclear spectroscopy--both experimental and theoretical. (auth)

**29695** CONTINUUM SHELL MODEL STUDY OF THE $^{16}O$ + NUCLEON PROBLEM. George, J. Tallahassee, FL; Florida State University (1974). 135p. University Microfilms Order No. 75-12,636.

Thesis (Ph. D.).

The compound resonances and the bound states observed in the nuclear system $^{16}O$ + nucleon are studied using the continuum shell model. The method of solution involves a division of configuration space as in the R-matrix theory. Shell model basis states which are eigenfunctions of the spherical harmonic oscillator potential are employed in the construction of trial wave functions for the internal region. The basis states contain active 1p/sub 1/2/, 1d/sub 5/2/ and 2s/sub 1/2/ orbits as well as higher orbits into which at most a single nucleon is placed. Excitations of up to four particles from the spherical closed core are included. The two-body interaction used in our model was taken from a shell model calculation on $^{18}O$ and $^{18}F$ by Zuker, supplemented by a central Gaussian interaction from True. Neutron total cross sections, proton and neutron phase shifts and neutron polarizations were calculated. The shell model structure of the resonant states is presented and discussed. The results show excellent qualitative and fair quantitative agreement with experiment. Some of the predicted resonances tend to be too narrow. We have carried out an investigation into the reasons for this discrepancy, but have obtained only a partial answer. Further study is suggested. (auth)

**29696** THREE-BODY BREAKUP OF $^{14}N$ INDUCED BY FAST NEUTRONS. Turk, M.; Antolkovic, B.; Winterhalter, D. (Inst. Ruder Boskovic, Zagreb). Fizika (Zagreb); No. 7, 1(Apr 1975)

The correlation spectra of the three-body breakup of the n + $^{14}N$ system have been studied at incident neutron energies of 14.4 MeV and 18.2 MeV. The Dalitz-plot analysis shows that the sequential decay proceeds either through the ground state of $^{8}Be$ or the 8.9-, 9.2-, 11.3-, 12.6-, and 14.0-MeV states of $^{11}B$, the last three being excited with 18.2-MeV neutrons. The relative contributions of the various decay modes are given. (1 table, 2 figures) (auth)

**29697** CORE-PARTICLE COUPLING CALCULATIONS FOR A = 18 NUCLEI: NON PERTURBATIVE EFFECTIVE INTERACTIONS IN THE (2s,1d) SHELL. Lo Iudice, N. (Naples Univ. (Italy). Istituto di Fisica Teorica); Rowe, D. J.; Wong, S. S. M. (Toronto Univ., Ontario (Canada). Dept. of Physics). Nucl. Phys., A; 245: No. 3, 479-508(7 Jul 1975).

A Hamiltonian composed of a harmonic oscillator one-body part and a bare reaction G-matrix as two-body interaction is diagonalized in a space spanned by states with two (valence) nucleons in the (2s, 1d) shell and states with two nucleons in (2s, 1d) plus Tamm-Dancoff or random-phase approximation phonons. An unperturbed particle-hole excitation energy of $2\hbar\omega$ = 28 MeV, as prescribed by the harmonic oscillator basis employed, is used to determine the phonon states; experimental single-particle energies are used otherwise. Effective interactions within the "model" space, namely the (2s, 1d) shell, are then derived through the use of biorthogonal states. The interactions so obtained correspond closely to folded linked-cluster expansions in G which include all possible terms of any order describing the interaction between the two valence particles and the phonons. This correspondence facilitates close comparisons with perturbative results of other authors and enables reliable conclusions to be drawn regarding the convergence of the series considered. More decisive conclusions in this respect are provided by an accurate investigation of the structure of the wave functions. It is argued that the series, whether corresponding to one or another kind of phonon, is unlikely to converge order by order in G and maybe does not converge at all. On the other hand, it is maintained that replacing the harmonic oscillator with a more "realistic" single-particle basis might improve drastically the convergence properties of the linked cluster expansion if not the fit to experiment. (auth)

**29698** PARTIAL MUON CAPTURE RATES IN $^{12}C$ FROM THE GENERALIZED HELM MODEL. Devanathan, V.; Subramanian, P. R. (Madras Univ. (India). Dept. of Nuclear Physics); Graves, R. D.; Ueberall, H. (Catholic Univ. of America, Washington, D. C. (USA)). Phys. Lett., B; 57: No. 3, 241-244(7 Jul 1975).

Partial capture rates in the reaction $\mu^- + ^{12}C \rightarrow \nu_\mu + ^{12}B$ are calculated using the generalized Helm model. The results are in good agreement with the recent experimental data. (auth)

**29699** PHOTONEUTRON CROSS SECTIONS FOR $^{9}Be$ OBTAINED WITH QUASI-MONOENERGETIC PHOTONS. Kneissl, U.; Kuhl, G.; Leister, K. H.; Weller, A. (Giessen Univ. (F. R. Germany). Abt. Grossgeraete (Angewandte Kernphysik)). Nucl. Phys., A; 247: No. 1, 91-102(28 Jul 1975).

Absolute ($\gamma$,xn) cross sections for $^{9}Be$ were measured with monochromatic photons from positron annihilation in flight in the energy range from 17 to 37 MeV. No pronounced structure was found in the cross sections in contrast to recent experiments performed with bremsstrahlung sources. The results are compared with many-particle shell model calculations. (auth)

**29700** ELASTIC SCATTERING OF 33 MeV POLARIZED $^{3}He$ PARTICLES BY BERYLLIUM AND CARBON. Burcham, W. E.; England, J. B. A.; Harris, R. G.; Karban, O.; Roman S. (Birmingham Univ. (UK). Dept. of Physics). Nucl. Phys., A; 246: No. 2, 269-281(21 Jul 1975).

Angular distributions of $^{3}He$ polarization in elastic scattering from $^{9}Be$ and $^{12}C$, and in inelastic scattering to the 4.44 MeV state of $^{12}C$, were measured using a 33 MeV polarized $^{3}He$ beam. The polarization and cross-section data were successfully analyzed in terms of the standard optical model. Selectivity of the $^{3}He$ elastic polarization for various potential sets was established in both optical model and coupled-channel analyses. While it is possible to determine unambiguously the geometry of the spin-orbit term, its strength is strongly correlated with other optical model parameters. (auth)

**29701** LOW LYING OCTUPOLE EXCITATIONS IN $^{15}N$. Kim, J. C.; Caplan, H. S.; Bergstrom, J. C. (Saskatchewan Univ., Saskatoon (Canada). Saskatachewan Accelerator Lab.). Nucl. Phys., A; 246: No. 2, 282-292(21 Jul 1975).

The inelastic electron scattering form factors for the 5.27 MeV ($5/2^+$), 7.15 MeV ($5/2^+$), 7.30 MeV ($3/2^+$) and 7.56 MeV ($7/2^+$) levels have been measured in the momentum transfer range between 0.6 and 1.1 $fm^{-1}$. The resulting B(E3) values are discussed in terms of weak-coupling models and the spherical shell model of Zuker, Buck and McGrory. (auth)

**29702** $^{11}C \rightarrow ^{11}B$ $\beta^+$ TRANSITION. Behrens, H.; Kobelt, M.; Szybisz, L.; Thies, W. G. (Karlsruhe Univ. (TH) (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Nucl. Phys., A; 246: No. 2, 317-322(21 Jul 1975).

The shape factor and the end-point energy of the $\frac{3}{2}^-$ (0.96 MeV $\beta^+$) $\frac{3}{2}^-$ transition in the decay of $^{11}C$ were accurately measured. No deviations from the allowed spectrum were found. The experimental ft value was evaluated. Theoretical calculations of the shape factor and ft value were done considering the wave functions of Cohen and Kurath; both experiment and theory are in agreement. (auth)

**29703** ELASTIC AND INELASTIC SCATTERING OF 24 MeV ALPHA PARTICLES BY CARBON-12 AND CARBON-13. Feofilov, G. A.; Denisov, A. E.; Kolalis, R. P.; Sadkovskii, V. S.; Chubinskii, O. V.; Andronov, Yu. F.; Vinogradov, L. I. (Leningrad State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 113-118(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2591-2597(1974).

The angular distributions of 24 MeV alpha particles scattered by $^{12}C$ and $^{13}C$ with the formation of ground and excited states have been measured at center of mass angles between 15° and 175°. The inelastic data for $^{13}C$ are reported for the first time in a broad range of angles. Standard optical model calculations and optical-model calculations with l-dependent imaginary part are used to interpret the elastic angular distributions. (10 figures) (auth)

**29704** POLARIZATION PHENOMENA DURING INELASTIC SCATTERING OF PROTONS BY LIGHT NUCLEI. Plavko, A. V. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 137-144(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2618-2626 (1974).

The angular dependences of the analyzing power for excitation of states in $^{16}O$, $^{24}Mg$, $^{28}Si$, and $^{40}Ca$ are reported. Excitation is produced via the inelastic scattering of polarized protons. (8 figures) (SDF)

**29705** TWO-PHOTON TRANSITIONS IN SPHERICAL NUCLEI. Kopytin, I. V.; Gvozdenko, V. A. Bull. Acad. Ser. USSR, Phys. Sci.; 38: No. 12, 171-176(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2657-2663(1974).

The Green function for the single-particle Schroedinger equation in the case of the oscillator potential and a potential in the form of a three-dimensional rectangular well of finite depth is constructed. The term corresponding to the spin-orbital interaction of the nucleon is taken into account. The Green function obtained in this way is then used to evaluate the matrix element for the two-photon nuclear transition. In the case of the oscillator potential, an analytic expression is obtained for the probability of the nuclear transition involving the emission of two gamma rays. This expression involves the hypergeometric function $_2F_1$. The case of the emission of two gamma rays of multipolarity $EL_1$ and $EL_2$ is discussed in detail and a numerical estimate is made of the probability $w_{\gamma\gamma}$ for $^{11}O$. (auth)

**29706** ELASTIC SCATTERING OF PROTONS BY $^{12}C$ AND THE ANALYZING POWER OF THE $^{12}C$(p VECTOR, p)$^{12}C$ PROCESS AT 4.5-6 MeV. Alekseev, N. V.; Gulamov, I. R.; Ignat'ev, S. B.; Romanovskii, E. A.; Sirotinin, E. I.; Spasskaya, T. I.; Shishkin, K. S.; Gubin, V. B. (Moscow State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 153-156(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2637-2641(1974).

The method of thick targets is used to determine the average energy dependence of the cross section and the analyzing power of elastic proton scattering by $^{12}C$ at 4.5-6.0 MeV. Results compare well with thin target measurements. (5 figures) (SDF)

**29707** DETERMINATION OF THE SPECTRUM AND WIDTH OF $\alpha$-CLUSTER STATES OF $^{16}O$ IN THE SURFACE POTENTIAL WELL MODEL. Gol'dberg, V. Z.; Gridnev, K. A.; Semenov, V. M. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 52-57 (1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 2524-2529(1974).

An attempt is made to describe the quasirotational spectrum of $^{16}O$, which consists of positive and negative parity bands, in terms of a model in which the $\alpha$-particle moves in the field of the core. The interaction between the $\alpha$-particle and the core is assumed to be of the surface type, i.e., described by a hard core potential. The periodic motions of the $\alpha$-particle are described in terms of the Majorana exchange forces which separate bands of different parity. The widths of the states are calculated. The numerical results of these calculations turn out to be somewhat greater than the experimental values, and this means that the core radius must be varied linearly with the $\alpha$-particle binding energy. A satisfactory description is achieved of the energies and widths of the quasi-rotational states of $^{16}O$, and the position of the $7^-$ state of $^{20}Ne$ and $^{28}Si$ is predicted. (2 figures, 1 table) (auth)

**29708** BACK SCATTERING OF HELIUM IONS BY LIGHT NUCLEI. Chernov, I. P.; Kuznetsov, B. I.; Kozyr, V. V.; Matusevich, V. A. (Tomsk Polytechnic Inst., USSR). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 58-65(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2530-2538(1974).

The mechanism responsible for the back scattering of helium ions is discussed. A qualitative and theoretical analysis leads to the conclusion that the anomalous increase in the back-scattering cross section is largely due to the contribution of resonance scattering. (11 figures, 1 table) (auth)

**29709** ($\alpha$,$\alpha$n) REACTION ON $^9Be$ AT 27.2 MeV. Grantsev, V. I.; Dryapachenko, I. P.; Kornilov, V. A.; Nemets, O. F.; Pugach, V. M.; Rudenko, B. A.; Sokolov, M. V.; Struzhko, B. G. (Inst. of Nuclear Research, Kiev). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 69-71(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR. Ser. Fiz.; 38: No. 12, 2543-2546(1974).

Because of the long lifetime of $^8Be$(g.s.) ($3 \times 10^{-16}$ sec), this reaction may be looked upon as a three-particle reaction. The measured two-dimensional energy spectra of coincidences between the emitted alpha particles and neutrons contain strong peaks corresponding to the resonant interaction between the alpha particle and the neutron in the final state through $^5He$(g.s.). It is concluded that the ground state of $^9Be$ must be looked upon as the cluster formation $^5He$(g.s.) + $\alpha$. (2 figures) (auth)

**29710** INTERFERENCE EFFECTS IN THE $^7Li + D \rightarrow \alpha + \alpha + N$ REACTION. Grantsev, V. I.; Dryapachenko, I. P.; Kornilov, V. K.; Lyubanskii, G. B.; Nemets, O. F.; Ofengenden, R. G.; Pugach, V. M.; Rudenko, B. A.; Sokolov, M. V.; Struzhko, B. G.; Shchur, A. M. (Inst. of Nuclear Research, Kiev). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 72-74(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2547-2549(1974).

Measurements are reported of the angular and energy distributions of alpha particles from the $^7Li + d \rightarrow \alpha_1 + \alpha_2 + n$ reaction at deuteron energy of 4.0 MeV. It is shown that the main contribution to the three-particle final state of this reaction is due to successive mechanisms involving the formation of $^5He$(g.s.) and $^8Be^*$ (16.6 MeV) at the intermediate stages of the reaction. It is concluded that the increase in the cross section at $\theta_{\alpha_2} = 70°$ for $^8Be^*$ is determined by the angular distribution of the neutrons. A method was proposed for obtaining the angular distribution of neutrons from the $^7Li + d \rightarrow n + {}^8Be^*$ reaction (16.6 MeV). (3 figures) (auth)

**29711** MECHANISM OF THE ($\alpha$T) REACTION ON $^7Li$, $^{10,11}B$, AND $^{13}C$. Dmitrieva, T. A.; Lebedev, V. M.; Markman, V. G.; Spasskii, A. V.; Teplov, I. B. (Moscow State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 91-96(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2567-2573(1974).

Measurements have been carried out of the angular distributions of tritons from the ($\alpha$t) reaction on $^7Li$, $^{10,11}B$, and $^{13}C$ at angles between 20° and 175° and alpha-particle energies between 20 and 25 MeV. For the $^{10}B(\alpha t)^{11}C$ reaction, the angular distribution (30-100°) has been determined for a group of tritons corresponding to the formation of the $^{11}C$ nucleus in the 2.00 MeV, $1\text{-}2^-$ state. The experimental results are reviewed qualitatively within the framework of simple direct and resonant intermediate processes. (6 figures, 1 table) (auth)

**29712** ASYMMETRIES IN THE ANGULAR CORRELATIONS FOR THE $^7Li + d \rightarrow 2\alpha + n$ REACTION AT $E_d$ FROM 0.8 MeV TO 1.2 MeV. D'Amico, V. (Univ., Messina, Italy); Fazio, G.; Jannelli, S.; Mezzanares, F.; Potenza, R. Lett. Nuovo Cim.; 13: No. 13, 489-492(26 Jul 1975).

The bidimensional spectra of two alpha particles from the $^7Li + d \rightarrow 2\alpha + n$ reaction were detected using surface barrier detectors. The angular correlations show marked asymmetry with respect to the direction of motion of the $\alpha$-n complex in the center of mass system. It is hypothesized that the asymmetry in the decay of the $\alpha$-n complex is directly related to the neutron polarization in the n-$\alpha$ scattering. (SDF)

**29713** $^{11}B$ ($^7Li$,t) REACTION AND 4p-5h NEGATIVE PARITY STATES IN $^{15}N$. El-Bedewi, F.; Shalaby, M.; Embaby, S. (Ein Shams Univ., Cairo). J. Phys., G (London); 1: No. 5, 534-542 (20 Jun 1975).

The four particle transfer $^{11}B$ ($^7Li$,t) reaction has been studied at 12 MeV incident energy. Triton angular distributions corresponding to 18 energy levels in $^{15}N$ below 10.8 MeV excitation are presented. Those exhibiting pronounced structures and indicative of direct reaction mechanisms have been compared with Coulomb distorted plane wave model. The angular momenta of the transferred $\alpha$ clusters together with their relative reduced widths have been derived. Significant $\alpha$ clustering has been observed for six states in $^{15}N$ above 9 MeV excitation energy. Negative parity states at 9.152 ($\frac{3}{2}^-$), 9.827 ($\frac{1}{2}^-$), 9.925 ($\frac{1}{2}^-$) and 10.458 ($\frac{3}{2}^-$) MeV are found to possess appreciable 4p-5h character. (auth)

**29714** $^{16}O(d,^3He)^{15}N$ REACTION, REACTION MECHANISM, AND NUCLEAR STRUCTURE. Firestone, M. A. Ann Arbor, MI; Univ. of Michigan (1974). 189p. University Microfilms Order No. 75-10,169.

Thesis (Ph. D.).

Core excitations in the $^{16}O$ ground state were investigated by means of the $^{16}O(d,^3He)^{15}N$ reaction at 29.0 MeV, using The University of Michigan 83" cyclotron. Angular distributions, in the range equals 15-55°, were measured for transitions leading to $^{15}N$ levels up to 10 MeV in excitation. A gas target with a detector telescope in the scattering chamber was used for most of the

measurements. However, a solid target and magnetic analysis were required to resolve the transitions to the 5.27, 5.30 MeV doublet in $^{15}$N. The angular distributions were subjected to DWBA, Hauser-Feshbach, and CCBA analyses. The CCBA calculations were performed elsewhere in cooperation with the present work. Only the distributions from the transitions to the strong $^1/_2^-$ ground and $^3/_2^-$ 6.32 MeV states were well described by DWBA. The weak transitions have little structure except for the one to the $^1/_2^+$ state at 5.30 MeV. Attempts to extract spectroscopic factors for these transitions, via a DWBA analysis, gave unreasonably large values. Upper limits from compound nucleus formation of 5-35 percent to the total cross section were estimated for the weak positive parity transitions, with the specific percentage dependent upon the spin, parity, and excitation energy of the residual state. The CCBA analysis for the transitions to the $^5/_2^+$ 5.27 MeV, $5.2^+$ 7.16 MeV, and $^7/_2^+$ 7.57 MeV states was performed using theoretical spectroscopic amplitudes calculated from the "weak coupling" model wave functions of Ellis and Engeland. The agreement with experiment, for both shape and magnitude, was very good and did not require any normalization. This result, and the failure of the DWBA and compound nucleus mechanisms to describe the weak transitions leads to the conclusion that a complete CCBA analysis is required to understand most of the transitions populated in this experiment. Thus, shell breaking in the $^{16}$O ground state cannot be measured simply by assuming a direct one-step (DWBA) reaction mechanism. (auth)

**29715** NEW CROSS SECTION MEASUREMENTS FOR THE REACTION $^{16}$O(p,$\gamma$)$^{17}$F WITH AN EXTRAPOLATION TO ASTROPHYSICAL ENERGIES. Hall, T. H. Vancouver, BC; Univ. of British Columbia (1974). vp. National Library of Canada, Ottawa.

Thesis (Ph. D.).

Improved absolute cross section and angular distribution measurements have been made for the direct radiative capture of protons by $^{16}$O. Gamma ray yields have been obtained at four center of mass energies from 1.288 to 2.404 Mev for direct capture to the $d_{\frac{5}{2}}^+$ ground state of $^{17}$F and at seven center of mass energies from 0.795 to 2.404 Mev for direct capture to the $s_{\frac{1}{2}}^+$ first excited state. Angular distribution data have been obtained for both transitions for three angles at 0.778 Mev and four angles at each of 1.289, 1.840 and 2.306 Mev in the center of mass. In addition, separate measurements have determined differential cross sections to $\pm 0.5\%$ for the elastic scattering of protons by $^{16}$O at 171.5° in the center of mass from the energy region of pure Rutherford scattering to 2.0 MeV bombarding energy. The direct capture cross section was normalized to the elastic scattering cross section by a technique which allowed simultaneous observation of both reactions. The reaction $^{16}$O(p,$\gamma$)$^{17}$F is important in stellar astrophysics through the role it plays in the CNO bi-cycle. Its cross section at stellar energies affects the relative abundances of the catalyst nuclei carbon, nitrogen and oxygen in those stars which are burning hydrogen by this cycle of reactions. By lending confidence to, and providing an accurate normalization for the direct capture calculations, the present measurements allow a reliable extrapolation of the theory to stellar thermal energies. For center of mass energies below 100 Kev, the contributions to the astrophysical S-factor from capture to the $^1/_2^+$ first excited state and the $^5/_2^+$ ground state of $^{17}$F are calculated. The large energy dependence of $S_{(\frac{1}{2}^+ \text{ state})}$, in particular its dramatic increase with decreasing energy in the region of thermal energy, arises from the low binding energy of the $^1/_2^+$ first excited state. Consequently, the $^{16}$O(p,$\gamma$)$^{17}$F reaction rate at stellar thermal energies is determined almost entirely by direct capture to this state. (auth)

**29716** TWO-STEP PROCESSES. Wolter, H. H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik; Koeln Univ. (F. R. Germany). 1. Physikalisches Inst.). pp 140-151 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

Higher-order processes are examined as they are manifested in elastic and inelastic transfer reactions, particularly in the $^{16}$O and $^{17}$O scattering. It is demonstrated that the two-step transfer processes are very important. The dependence of such processes on the optical potentials is discussed. (auth)

**29717** FRAMEWORK FOR LOW ENERGY NUCLEAR SCATTERING. I. $^{12}$C(d,d)$^{12}$C SCATTERING IN DIRECT CHANNEL REGGE FORMALISM. Gupta, K.; Chowdhury, A. R.; Roy, T. (Jadavpur Univ., Calcutta). J. Phys., G (London); 1: No. 6, 646-651(1 Aug 1975).

Low energy carbon deuteron scattering is analyzed in the framework of direct channel Regge poles as an initial attempt to visualize the nuclear phenomena from a particle physicist's point of view. A single pole approximation is made corresponding to the existence of the state $^{14}$N as the intermediate state. A good fit to the experimental polarization data is obtained with the following parameters of the trajectory: Re $\alpha(S_0)$ = spin = 1 and Im $\alpha(S_0)$ = 0.07. The parameters so obtained are seen to predict the shape of the differential cross section well over the whole range. (auth)

**29718** ELASTIC ELECTRON SCATTERING FROM $^{14}$N, $^{15}$N, $^{16}$O, AND $^{18}$O AT LOW MOMENTUM TRANSFER. Schuetz, W. (Technische Univ. Darmstadt (F. R. Germany). Inst. fuer Kernphysik). Z. Phys., A; 273: No. 1, 69-75(May 1975). (In German).

2 figs.; 7 tabs.; 48 refs. Condensed version of the thesis of the TU Darmstadt. Full test available from ZAED under Nr. DD-10.

Elastic electron scattering cross sections of $^{14}$N and $^{16}$O have been measured relative to the proton and of $^{15}$N and $^{18}$O relative to the lighter isotope ($^{14}$N, $^{16}$O resp.) using gas targets. The momentum transfer ranged from 0.22 to 0.48 fm$^{-1}$. The data were analyzed by phase shift calculations assuming harmonic oscillator shell model charge distributions. (GE)

**29719** ALPHA PARTICLE EMISSION FOR $^{16}$O AND $^{20}$Ne IN THE GIANT DIPOLE RESONANCE REGION. Skopik, D. M.; Shin, Y. M.; Murphy, J. J. II. (Saskatchewan Univ., Saskatoon, Canada). Can. J. Phys.; 53: No. 14, 1398-1399(15 Jul 1975).

The electrodisintegration cross sections, $^{16}$O(e,$\alpha_0$)$^{12}$C,e' and $^{20}$Ne(e,$\alpha_0$)$^{16}$O,e', have been measured and, by using virtual photon analysis, a comparison with photodisintegration experiments has been made. Satisfactory agreement with earlier $^{12}$C($\alpha$,$\gamma_0$)$^{16}$O experiments was found and the $^{20}$Ne($\gamma$,$\alpha_0$)$^{16}$O reaction reveals several pronounced resonances. (auth)

**29720** LOW-LYING OCTOPOLE EXCITATIONS IN $^{17}$O. Kim, J. C.; Yen, R.; Auer, I. P.; Caplan, H. S. (Saskatchewan Univ., Saskatoon (Canada). Saskatchewan Accelerator Lab.). Phys. Lett., B; 57: No. 4, 341-344(21 Jul 1975).

Inelastic electron scattering experiments were performed on a $^{17}$O gas target in a range of momentum transfer q = 0.6 – 1.1 fm$^{-1}$; B(E3) values for twelve odd-parity levels were obtained from the measured Coulomb form factors. The results are discussed in terms of the weak coupling model. (auth)

**29721** AN ANALYSIS OF SOME PROTON-NUCLEUS SCATTERING DATA AT 1 GeV. Ahmad, I. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France). Dept. de Physique Nucleaire). Nucl. Phys., A; 247: No. 3, 418-440(11 Aug 1975).

The elastic and inelastic scattering data of 1 GeV protons on $^{12}$C, $^{39}$K, $^{40,48}$Ca, $^{58}$Ni and $^{208}$Pb are analysed within the framework of Glauber theory. The collective excitations to one-phonon levels are treated using the Tassie model under the adiabatic approximation. Effects of both the coupling between the elastic and the inelastic channels and the two-body correlation in the intrinsic state are considered. The ground state and transition densities for the protons are taken from electron scattering experiments and appropriate assumptions for the neutron densities are made. In most of the cases, better agreement with the experimental data than reported in earlier analyses is obtained. The effects of the coupling and the pair correlation seem to be important only for $^{12}$C. The elastic data strongly indicate that the density distributions for protons and neutrons in $^{48}$Ca and $^{208}$Pb are different. In $^{48}$Ca, the surface envelope of the neutron distribution is found to be the same as for the proton distribution but is placed at a larger radius. On the other hand, the neutron distribution in $^{208}$Pb seems to be relatively much more diffuse. (auth)

## Nuclear Properties and Reactions, 20 ≤ A ≤ 38

*Refer also to abstracts 29656, 29670, 29681, 29691, 29693, 29704, 29756, and 29958.*

**29722** CONTRIBUTION OF NUCLEAR DIAGRAMS TO INTERNAL BREMSSTRAHLUNG. Batkin, I. S.; Smirnov, Yu. G. (Voronezh State Univ., USSR). Yadern. Fiz.; 21: No. 4, 744-752(Apr 1975). (In Russian).

General formulae are obtained for the contribution of nuclear diagrams to the internal bremsstrahlung which accompanies the $\beta$ decay. The calculations were particularly made for the nuclei $^{137}$Cs and $^{32}$P in the one-body approximation with a continuous spectrum and in the single-resonance-level approximation. The results are compared with the shape of the internal bremsstrahlung spectrum calculated without nuclear diagrams. (1 table, 3 figures) (auth)

**29723** SPIN AND PARITY ASSIGNMENTS FOR $^{33}$S LEVELS FROM THE $^{29}$Si($\alpha$,n)$^{32}$S REACTION. Sanin, L. G.; Schier, W. A.; Barnes, B. K.; Couchell, G. P.; Egan, J. J.; Harthar, P.; Mittler, A.; Sheldon, E. (Lowell Technological Inst., Mass. (USA). Dept. of Physics). Nucl. Phys., A; 245: No. 2, 317-335(30 Jun 1975).

In $^{29}$Si($\alpha$,n$_0$)$^{33}$S excitation functions measured at 0° and 160° between $E_\alpha$ = 3.5-5.5 MeV, sharp resonances have been located corresponding to $^{33}$S levels at excitation energies between 10.19 and 11.98 MeV. Forty-two on-resonance angular distributions were measured and normalized to an absolute cross-section scale. Spin 1/2, 3/2, 5/2 and 7/2 states in $^{33}$S have been identified via the characteristic shape of the single-level angular distributions. An analysis employing both single-level and coherently admixed two-level theory which is sensitive to both shape and magnitude of the on-resonance distributions has furnished spin and parity assignments to single- and twin-level resonances. An optical potential of the Woods-Saxon volume-absorption type has been deduced for $\alpha$-particles providing agreement with the $^{13}$C, $^{19}$F, $^{29}$Si and $^{31}$P $\alpha$-particle scattering and alpha-nucleon data. (auth)

**29724** MATRIX ELEMENT FOR THE 1d/sub 3/2/-1f/sub 7/2/ INTERACTION AND THE $^{37}$Cl(d,p)$^{38}$Cl AND $^{39}$K(d,p)$^{40}$K REACTIONS. Fink, C. L.; Schiffer, J. P. (Argonne National Lab., Ill. (USA)). Nucl. Phys., A; 225: No. 1, 93-108(4 Jun 1974).

Differential cross sections have been measured for the $^{37}$Cl(d,p)$^{38}$Cl and the $^{39}$K(d,p)$^{40}$K reaction at 12 MeV using a magnetic spectrograph. Spectroscopic factors were obtained for states in $^{38}$Cl and $^{40}$K. In addition, two-body matrix elements were obtained for $^{38}$Cl and $^{40}$K and compared to the two-body matrix elements found from $^{34}$Cl and $^{34}$S. The matrix elements obtained from $^{38}$Cl and $^{40}$K are now in good agreement with the $^{34}$Cl and $^{34}$S results but the resulting Pandya transformation between $^{38}$Cl and $^{40}$K is now satisfied less well. (auth)

**29725** FOLDING MODEL ANALYSIS OF INELASTIC HELION SCATTERING FROM $^{20}$Ne. Mackintosh, R. S. (Oxford Univ. (UK). Nuclear Physics Lab.); de Swiniarski, R. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). Phys. Lett., B; 57: No. 2, 139-142(23 Jun 1975).

The scattering of 68 MeV helions from $^{20}$Ne has been analyzed with a folding model. The effects of changing the range of the interaction and the inclusion of exchange upon the extracted parameters were studied. A stable value of the quadrupole moment was found which agreed with that found from (e,e'). This agreement and the possibility of discriminating between different parameterizations of the nuclear shape suggest the possible superiority of helions over alpha particles for nuclear shape determination. (auth)

**29726** NUCLEAR SPINS AND MAGNETIC MOMENTS OF $^{29}$Na AND $^{39}$K BY $\beta$-RADIATION DETECTED OPTICAL PUMPING. Schweickert, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Zyklotronlaboratorium); Dietrich, J.; Neugart, R.; Otten, E. W. (Heidelberg Univ. (F. R. Germany). 1. Physikalisches Inst.). Nucl. Phys., A; 246: No. 1, 187-209(14 Jul 1975).

$^{29}$Na ($T_{1/2}$ = 445 ms) and $^{39}$K ($T_{1/2}$ = 340 ms) have been produced in rare gas targets by (p,n) reactions and polarized by means of spin-exchange scattering with optically pumped $^{87}$Rb. The asymmetry in the $\beta$-decay of polarized nuclei served to detect r.f. transitions between h.f.s. Zeeman levels of the atomic ground states, yielding spins I($^{29}$Na) = 2, I($^{39}$K) = 2, and h.f.s. splitting $\Delta W$ ($^{29}$Na) = 276.855(3) MHz, $\Delta W$($^{39}$K) = 604.5 (1.1)MHz from which the magnetic moments $\mu$($^{29}$Na) = 0.3694(2) n.m. and $\mu$($^{39}$K) = 0.548(2) n.m. (corrected for diamagnetism) were deduced. The magnetic moments are discussed in connection with $^{29}$F and $^{35}$Cl, the mirror nuclei belonging to the same isospin triplets. (auth)

**29727** NUCLEON-EXCHANGE TYPE CHARGE-EXCHANGE PROCESS AND THE SPIN FORBIDDEN ($^6$Li, $^6$He) TRANSITIONS. Kubo, K. I. (Tokyo Univ. (Japan). Dept. of Physics). Nucl. Phys., A; 246: No. 1, 246-268(14 Jul 1975).

The second order DWBA formalism for the nucleon pick-up and stripping type two-step process is presented for the cases of exact finite-range interaction, no re-coil approximation and zero-range approximation. The several first-order "spin forbidden" charge-exchange ($^6$Li, $^6$He) transitions are investigated by such direct nucleon-exchange mechanisms. They are the analog transitions: $^{26}$Mg(0$^+$) → $^{26}$Al(0.226 MeV 0$^+$) and $^{42}$Ca(0$^+$) → $^{42}$Sc(g.s.0$^+$), and the natural parity state excitations: $^{46}$Ca(0$^+$) → $^{46}$Sc(g.s. 6$^+$ and 0.253 MeV 4$^+$). The spin-flip mechanisms using a spin-independent force through the direct nucleon-exchange process are discussed. This type of two-step approach can provide a satisfactory interpretation for these transitions. It may also indicate a strong nucleon-exchange type charge-exchange mechanism for allowed transitions. (auth)

**29728** STUDY OF THE $^{28}$Mg NUCLEUS BY THE REACTION $^{26}$Mg(t,p$\gamma$)$^{28}$Mg. Rastegar, B.; Guillaume, G.; Fintz, P.; Gallmann, A. (Centre National de la Recherche Scientifique, 67-Strasbourg (France). Centre de Recherches Nucleaires). Nucl. Phys., A; 225: No. 1, 80-92(4 Jun 1974). (In French).

Angular correlation and Doppler shift attenuation methods were used to measure $\gamma$-ray branching ratios, spins, mixing ratios and lifetimes of $^{28}$Mg excited states between 4.9 and 5.8 MeV, produced in the $^{26}$Mg(t,p$\gamma$) reaction at $E_t$ = 2.54, 2.90 and 3.20 MeV. Gamma rays were detected in coincidence with proton groups, observed at 0° and 180° for the angular correlation measurements, and at 180° for the DSA measurements. The results for the excitation energies (keV), $J^\pi$ and $\tau_m$(ps) are: 5171.9 ± 0.5.3, 3$^-$, 0.18 ± 0.02; 5192.7 ± 0.7, 1$^-$, < 0.06; 5271.7 ± 1.01, 1$^-$, < 0.14; 5702.3 ± 0.7, 0$^+$, 0.30 ± 0.05. Two previously unreported levels were identified at 4560.8 ± 0.8 keV (J = 1) and 5184.6 ± 0.7 keV. Other levels have been observed at 5469.1 ± 0.8 and 5672.8 ± 0.8 keV ($J^\pi$ = 2$^+$). The $^{28}$Mg spectrum is compared with other experimental results and with recent theoretical predictions. (auth)

**29729** HIGH-RESOLUTION STUDY OF PROTON RESONANCES IN $^{31}$P, $^{35}$Cl, AND $^{93}$Tc. Outlaw, D. A. Raleigh, NC; North Carolina State University (1974). 160p. University Microfilms Order No. 75-10,416.

Thesis (Ph. D.).

Differential cross sections were measured for $^{30}$Si(p,p) from 1.08 to 3.00 MeV and $^{34}$S(p,p) from 1.46 to 2.82 MeV at laboratory angles of 160$^0$, 135$^0$, 105$^0$, and 90$^0$. The differential cross section for $^{92}$Mo(p,p) was measured from 5.13 to 5.43 MeV at 160$^0$, 125$^0$, and 90$^0$. The resonances observed in the excitation functions were analyzed in terms of the parameters of the R-matrix theory. Resonance energies, spins, parities, and proton widths were extracted for 62 resonances in $^{31}$P, 59 resonances in $^{35}$Cl, and 125 resonances in $^{93}$Tc. The analogs of the 2.317- and 3.133-MeV states in $^{31}$Si were positively identified and the analog of the 2.790-MeV state was tentatively identified. The analog of the 2.348-MeV state in $^{35}$S was positively identified, and the analogs of the 2.718, 2.939, and 3.421 states were tentatively identified. The highly fragmented analog of the first excited state in $^{93}$Mo was studied. Coulomb energies for each of the analog states were determined. Spectroscopic factors were determined for each of the observed analog states. A fit to the theoretical fine-structure distribution was obtained for the highly fragmented s-wave analog state in $^{93}$Tc, and the fine-structure parameters were extracted. Seven very large 3/2$^-$ states were observed in $^{31}$P. The proton widths obtained in these experiments were combined with capture data in order to extract gamma-ray widths for resonances in $^{31}$P and $^{35}$Cl. The proton strength functions for each spin and parity observed were determined for each isotope studied. The qualitative features of the proton strength functions from A equals 30 to A equals 64 were discussed. (Diss. Abstr. Int., B)

**29730** $^{24}$Mg(alpha,gamma)$^{28}$Si REACTION AT ALPHA-PARTICLE ENERGIES FROM 3.2 TO 6.2 MeV. Slack, S. T. University Park, PA; Pennsylvania State Univ. (1974). 57p. University Microfilms Order No. 75-9845.

Thesis (Ph. D.).

The $^{24}$Mg(alpha,gamma)$^{28}$Si reaction has been used to study excited states in $^{28}$Si. Targets of enriched $^{24}$Mg on a tantalum backing were bombarded by an alpha-particle beam from the CN Van de Graaff accelerator of The Pennsylvania State University. A large NaI(Tl) detector was placed immediately adjacent to the target in order to increase the probability of summing of the signals from different members of a cascade; windows were set for transitions to the ground state and the first few excited states. The energy of the alpha-particles was increased in steps of 2 to 5 keV from 3.2 to 6.2 MeV. Thirty-two resonances were located by sharp increases in the number of events recorded. At each resonance a spectrum was taken using a 55 cm$^3$ Ge(Li) detector placed 5 cm from the target at an angle of 55$^0$ to the beam axis, the data being recorded on a PDP-15 on-line computer. The spectra were analyzed off-line using the program SAMPO of the Lawrence Berkeley Laboratory. (Diss. Abstr. Int., B)

**29731** $^{40}$Ar(d,p)$^{41}$Ar REACTION AT DEUTERON ENERGIES BELOW THE COULOMB BARRIER. Cavallaro, S.: Corleo, G.; Cunsolo, A.; Foti, A.; Giambruno, S.; Di Toro, M.: Pappalardo, G. (Univ., Catania, Italy). Nuovo Cim., 28A: No. 1, 12-20 (1 Jul 1975).

Spectroscopic factors are obtained from stripping reactions at energies below the Coulomb barrier. Compound-nucleus effects are taken into account. The dependence of spectroscopic factors on the energy of the incident particle, on the nuclear optical parameters and on the geometrical parameters of the captured-neutron potential well is investigated in detail. (2 tables, 5 figures) (auth)

**29732** $^{28}Si(^3He,\alpha)^{27}Si$ REACTION AT 14 MeV BOMBARDING ENERGY. Wen-Ming; Lin, C. S.; Song, P. S.; Chou, J. C. (Atomic Energy Council, Lungtan, Taiwan). Nuovo Cim., 27A: No. 4, 412-420(21 Jul 1975).

The angular distributions of the $^3He$ and $\alpha$-particles emitted from a silicon target bombarded with a 14 MeV doubly charged $^3He$ beam have been measured at 20 angles between 10° and 110° with a surface barrier solid-state detector. The analysis of the elastic scattering $^{28}Si(^3He,^3He)^{28}Si$ with the optical model and the analysis of the $^{28}Si(^3He,\alpha)^{27}Si$ angular distributions with the DWBA theory indicate that these reactions are mainly direct in nature. Within the limitations discussed in the text, spectroscopic factors of 2.92, 0.32, 0.39, and 0.61 were assigned to the ground state and the 0.78 MeV, 0.96 MeV and 2.65 MeV excited states, respectively. (3 tables, 4 figures) (auth)

**29733** REACTIONS $^{20}Ne(t,p)^{22}Ne$ AND $^{21}Ne(t,d)^{22}Ne$ AT E = 3 AND 3.4 MeV. Chambon, B. (Univ., Lyon); Bersillon, O.; Drain, D.; Lambert, M.; Madjar, N.; Pastor, C.; Beaumevieille, H.; Dauchy, A.; Morand, C. Nuovo Cim., 27A: No. 4, 421-439 (21 Jul 1975). (In French).

Absolute differential cross-sections were measured for proton groups from the $^{20}Ne(t,p)^{22}Ne$ reaction at 3 and 3.4 MeV and for two deuteron groups from the $^{21}Ne(t,d)^{22}Ne$ reaction at 3 MeV with a gas cell containing $^{20}Ne$ or $^{21}Ne$. The total cross-sections of most groups were analysed in terms of Hauser–Feshbach theory and several final-state spin predictions are made. The angular distribution of the $^{20}Ne(t,p)^{22}Ne$ (E = 6.24 MeV) reaction was analysed by double-stripping DWBA theory and indicates $0^+$ for this state, the isobaric analogue of which has been identified at 6.83 MeV in $^{22}Na$. (2 tables, 8 figures) (auth)

**29734** GAMMA RAYS FROM $^{23}Na$ STATES EXCITED IN THE $^{12}C(^{12}C,p)$ REACTION AT E EQUALS 38.6 MeV. Cormier, T. M.; Cosman, E. R.; Grodzins, L.; Hansen, O.; Steadman, S.; Van Bibber, K.; Young, G. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science). Nucl. Phys., A; 247: No. 2, 377-381(4 Aug 1975).

The $^{12}C(^{12}C,p\ gamma)^{23}Na$ reaction was studied at a c.m. bombarding energy of 19.3 MeV. At this energy the excitation functions for the proton groups to the 9.04 MeV and 9.81 MeV $^{23}Na$ states exhibit a strong resonance. The gamma-decay of the 9.04 and 9.81 MeV levels was recorded and found to be consistent with the two states being the $^{15}/_{2}^{+}$ and $^{17}/_{2}^{+}$ members, respectively, of the $^{23}Na$ ground-state rotational band. Other nearby spin values cannot be excluded. (auth)

**29735** ($^3He$,d) REACTION ON $^{24}Mg$ AND $^{28}Si$ AT 38.5 MeV. Peterson, R. J.; Ristinen, R. A. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.). Nucl. Phys., A; 246: No. 2, 402-412(21 Jul 1975).

The ($^3He$,d) reaction at a sufficiently high energy is considered to be a reliable single-proton stripping direct reaction. The data for the low-lying states produced by this reaction on $^{24}Mg$ and $^{28}Si$ are compared to the predictions of the strong-coupling rotational model. The agreement with the model predictions for $^{25}Al$ is quite good, both for the single-proton spectroscopic factors in that nucleus and most particularly for the excitation of $^{7}/_{2}^{+}$ states in $^{25}Al$ and $^{29}P$ by two-step processes. (auth)

**29736** REACTIONS OF $^{14}N$ AND $^{16}O$ IONS WITH p AND s–d SHELL NUCLEI AT E/sub lab/ EQUALS 16 TO 75 MeV. Holub, R.; Zeller, A. F. (Florida State Univ., Tallahassee (USA). Dept. of Chemistry); Plendl, H. S.; DeMeijer, R. J. (Florida State Univ., Tallahassee (USA). Dept. of Physics). Nucl. Phys., A; 246: No. 2, 515-532(21 Jul 1975).

Yield curves were measured for formation of $^7Be$ and of residual nuclei formed by alpha-particle and nucleon emission following the reactions of 16- to 75-MeV $^{14}N$ and $^{16}O$ ions with thick, natural C, Mg, Al and Si targets. The results are discussed in terms of statistical model calculations. Yield curves calculated with computer codes based on the statistical model are compared with the experimental results. (auth)

**29737** THE GAMMA DECAY OF THE RESONANCES OF THE REACTION $^{31}P(p,\gamma)^{32}S$ BY Ep = 1,02 MeV. Du Toit, G. D. Potchefstroom, South Africa; Potchefstroom Univ. (1974). 59p. (In Afrikaans). INIS.

Thesis.

The nuclear energy levels of $^{32}S$ were investigated by means of the gamma decay of the nucleus from the excited state. Excitation of $^{32}S$ was achieved by the bombardment of $^{31}P$ with accelerated protons having energies smaller than 1,02 MeV. A Cockroft-Walton accelerator was used by which it was possible to obtain a current as high as 130$\mu$A on the target. The target material was prepared by vacuum precipitation of $Zn_2P_3$ onto copper supports. These provided a satisfactory reaction rate and could also withstand the high temperature. A higher accuracy was achieved in the determination of the gamma energies by means of a Ge(Li)-detector for which the energy resolution is of the order of 0.8% compared to about 8% for the usual NaI-detector. Computer programs were used as an aid to interpret the gamma spectra and enabled the intensities and energies of the gamma peaks to be determined with high accuracy. The resonance curve for the reaction $^{31}P$ (p,$\gamma$) $^{32}S$ was measured for E < 1.02 MeV. Eleven resonance levels were excited, and the branching ratios of the gamma decay of each, as well as the Q-value of the reaction, were determined. In addition to this, the energies and branching ratios of fifteen bounded levels were determined. The results are in good agreement with some previous measurements but a higher accuracy was achieved in this experiment. (auth)

**29738** CONFIGURATION DEPENDENT L = 0 SHAPES IN $^{32}S(t,p)^{34}S$. Crozier, D. J.; Fortune, H. T. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). Phys. Lett., B; 57: No. 3, 228-230(7 Jul 1975).

In the $^{32}S(t,p)^{34}S$ reaction at 10 MeV, qualitative differences appear in the $0^+ \rightarrow 0^+$ angular distributions even at forward angles. Qualitatively similar differences result from simple distorted-wave calculations, using pure microscopic configurations. (auth)

**29739** $^{29}Si(^3He,p)^{31}P$ REACTION. Nann, H.; Wildenthal, B. H. (Michigan State Univ., East Lansing (USA). Cyclotron Lab.); Duhm, H. H.; Hafner, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Nucl. Phys., A; 246: No. 2, 323-332 (21 Jul 1975).

Angular distributions of the $^{29}Si(^3He,p)^{31}P$ reaction at $E_{^3He}$ = 26 MeV have been measured for states in $^{31}P$ up to an excitation energy of 5.7 MeV. These data were analyzed with distorted-wave Born approximation calculations based on current shell-model wave functions. (auth)

**29740** MULTIPARTICLE NILSSON MODEL FOR $^{24}Mg$ AND $^{25}Mg$: EXPERIMENTS AND THEORY. DeLong, R. Minneapolis; Univ. of Minnesota (1974). 133p. University Microfilms Order No. 75-12,057.

Thesis (Ph. D.).

The $^{27}Al$(d, $^3He$)$^{26}Mg$ and $^{25}Mg(^3He,\alpha)^{24}Mg$ reactions were studied at 20 MeV and 28 MeV, respectively, using an Enge split-pole spectrometer. The differential cross sections were measured for the more strongly excited states in $^{26}Mg$ up to 5.48 MeV and in $^{24}Mg$ up to 12.5 MeV. Spectroscopic factors have been extracted using a standard DWBA analysis. Excellent agreement with the 1d5/2-2s1/2 shell model was found for both nuclei. Only fair agreement was found for spectroscopic factors calculated using the rotational model without bandmixing. Multiparticle Nilsson model calculations were performed which included bandmixing due to the Coriolis force and the $\langle J^2 \rangle$ term of the Hamiltonian. Excellent agreement was found between the $C^2S$ calculated using this model and those measured in the pickup reactions, however, the calculations for $^{24}Mg$ are incomplete as states of good isospin were not used. In both nuclei the strengths of the transitions to the $4^+$ members of the ground state rotational bands (the 4.90 MeV $4^+$ stated in $^{26}Mg$ and the 4.12 MeV $4^+$ state in $^{24}Mg$) can be explained in terms of mixing with strong $K^\pi = 4^+$ intrinsic states located at 4.320 MeV in $^{26}Mg$ and 8.436 MeV (T = 0) and 9.515 MeV (T = 1) in $^{24}Mg$. The elastic and inelastic scattering have been measured for both channels in the $^{27}Al$(d, $^3He$)$^{26}Mg$ reaction and for the incident channel in the $^{25}Mg(^3He,\alpha)^{24}Mg$ reaction. The results were analyzed using the optical model. The resulting parameters were used in the DWBA analysis of the transfer reactions. (auth)

**29741** THICK-TARGET MEASUREMENT OF PROTON POLARIZATION IN THE CASE OF ELASTIC SCATTERING. Romanovskii, E. A.; Gulamov, I. R.; Gubin, V. B.; Spasskaya, T. I.; Kalacheva, Z. F.; Goncharov, L. A. (Moscow State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 75-78(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2550-2553(1974).

A description is given of a method for measuring the energy dependence of the analyzing power of the elastic scattering of protons by nuclei, based on the use of thick targets. (2 figures) (auth)

**29742** ANALYZING POWER OF Si(p VECTOR, p) SCATTERING AT ENERGIES IN THE RANGE 5-6 MeV. Gulamov, I. R.; Romanovskii, E. A.; Spasskaya, T. I.; Gubin, V. B.; Tkachenko, V. A. (Moscow State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 79-81(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2554-2556(1974).

The method of thick targets was used to determine the angular and energy distributions of the analyzing power of $^{28}$Si(pp) scattering at energies between 5 and 6 MeV. It is shown that silicon can be used as an analyzer as polarized protons with energies of about 5 MeV if the asymmetry is measured at angles of about 160°. (2 figures) (auth)

**29743** ELASTIC SCATTERING OF 5-6 MeV PROTONS BY $^{34}$S. Gubin, V. B.; Kalacheva, Z. F.; Romanovskii, E. A.; Sirotinin, E. I.; Spasskaya, T. I.; Shishkin, K. S.; Rudnev, A. S. (Moscow State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 97-100(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2574-2577(1974).

Measurements are reported of the excitation function for elastic proton scattering by $^{32}$S and $^{34}$S at different scattering angles for proton energies between 5.4 and 6.2 MeV. The role of the excitation of different states in the resulting compound nuclei is discussed in terms of the shape of the energy and angular distributions of the scattering cross sections. (5 figures) (auth)

**29744** ELECTROMAGNETIC AND ANGULAR MOMENTUM PROPERTIES OF STATES IN $^{33}$S BELOW 5.0 MeV IN EXCITATION. Butler, P. A.; Brown, A. J.; Carr, P. E.; Green, L. L.; James, A. N.; Lister, C. J.; MacArthur, J. D.; Nolan, P. J.; Sharpey-Schafer, J. F. (Univ. of Liverpool). J. Phys., G (London); 1: No. 5, 543-557(20 Jun 1975).

The reaction $^{30}$Si($\alpha$,n)$^{33}$S was used to populate levels in $^{33}$S at $\alpha$-particle energies of 6.7, 8.0 and 9.8 MeV. Gamma rays in $^{33}$S were detected in a Ge(Li)-NaI(Tl) escape-suppressed spectrometer and a three Ge(Li) Compton polarimeter. The analysis of experimental angular distributions and linear polarizations gave new spin and parity assignments of $J^\pi = \frac{1}{2}^+, \frac{3}{2}^+, \frac{5}{2}^+, \frac{7}{2}^+, \frac{9}{2}^-$, and $11/2^-$ to the levels at 2866, 3935, 4048, 4094, 4729 and 4866 keV respectively, and ($\frac{3}{2}$, $\frac{5}{2}$) and ($\frac{7}{2}$, $\frac{9}{2}$) to the levels at 4375 and 4425 keV respectively. Also $\gamma$-ray multipole mixing ratios were unambiguously determined for many transitions from states below 5.0 MeV in excitation. The properties of the positive parity states are compared with predictions of shell model calculations. A description of the negative parity states in terms of the intermediate coupling vibrational model is made. (auth)

**29745** PRODUCTION OF $^{24}$Al FROM $\alpha$-PARTICLE BOMBARDMENT OF Mg, Al, AND Si. Tanaka, S.; Sakamoto, K.; Furukawa, M. (Tokyo Univ., Tanashi, Japan). J. Inorg. Nucl. Chem.; 37: No. 9, 2002(Sep 1975).

Measurements are reported of the excitation functions for the production of $Al^{24}$ in natural Mg, Al and Si from $\alpha$ particle bombardment at energies below 46 MeV. (UK)

**29746** MEASUREMENT OF THE SPIN-FLIP PROBABILITY IN THE INELASTIC SCATTERING OF 7.6 MeV NEUTRONS BY A SULFUR TARGET. Shope, T. B. Jr. Athens, GA; Univ. of Georgia (1974). 150p. University Microfilms Order No. 75-8211.

Thesis (Ph. D.).

The (n,n'gamma) angular correlation for gamma rays emitted perpendicular to the reaction plane was measured for 7.6 MeV neutrons inelastically scattered (Q equals -2.23 MeV) from $^{32}$S. The angular correlation was obtained for neutron laboratory scattering angles between 40° and 160° using time-of-flight technique in both gamma-ray and neutron detection systems. NaI crystal detectors mounted above and below the reaction plane were used to detect the gamma radiation from the deexcitation of the $2^+$ excited state of the target nucleus. The measured spin-flip probability angular distribution was peaked at about 110° with a maximum value of 0.33 +- .08. This is in contrast to the usual more backward angle peaking observed in proton spin-flip measurements at higher energies. The spin-flip probability was fit using a calculation employing an incoherent sum of compound-nucleus (CN) and direct interaction (DI) contributions to the reaction mechanism. Using generalized optical-model parameters, and later using values obtained from a parameter search, fair agreement was obtained for the elastic and inelastic cross section angular distributions. The DI contributions to the reaction mechanism were calculated using both a distorted-wave Born approximation calculation and a coupled-channel calculation. Both calculations failed to reproduce the spin-slip probability angular distribution. Calculated spin-flip probability distributions were peaked at more backward angles than the data. The position of the peak in the predicted spin-flip probability was relatively insensitive to the spin-orbit optical-model parameters while the magnitude was directly related to the strength of the spin-orbit potential in the present analysis. (auth)

**29747** ABSOLUTE YIELD MEASUREMENT OF THE REACTION $^{27}$Al($\gamma$,2pn)$^{24}$Na. Johnsson, B.; Jaerund, A.; Forkman, B. (Lund Univ. (Sweden). Dept. of Nuclear Physics). Z. Phys., A; 273: No. 1, 97-98(May 1975).

1 fig.; 1 tab.; 9 refs.

The reaction $^{27}$Al($\gamma$,2pn)$^{24}$Na is suitable as a secondary standard in high energy photonuclear studies. Thus, the absolute yields at bremsstrahlung maximum energies between 95 and 965 MeV were measured. (auth)

**29748** SPIN AND MAGNETIC MOMENT OF $^{25}$Na BY $\beta$-RADIATION DETECTED OPTICAL PUMPING. Deimling, M. (Heidelberg Univ. (F. R. Germany). 1. Physikalisches Inst.); Neugart, R. (Mainz Univ. (F. R. Germany). Inst. fuer Physik); Schweickert, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Kernphysik). Z. Phys., A; 273: No. 1, 15-17(May 1975).

1 fig.; 17 refs.

$^{25}$Na($T_{\frac{1}{2}}$ = 60 sec) was produced in a $^{22}$Ne target by the ($\alpha$,p) reaction and polarized by means of spin-exchange scattering with optically pumped $^{87}$Rb. The asymmetry in the $\beta$ decay of polarized nuclei served to detect rf transitions between hfs Zeeman levels of the atomic ground state, yielding spin $I = \frac{5}{2}$ and hyperfine splitting of 2,648.5(3.0)MHz, from which the magnetic moment $\mu_I$ = 3.683(4) nm (corrected for diamagnetism) was deduced. (auth)

**29749** HIGH SPIN STATES IN $^{39}$K. Nolan, P. J.; Brown, A. J.; James, A. N.; Lister, C. J.; Sharpey-Schafter, J. F. (Univ. of Liverpool). J. Phys., G (London); 1: No. 6, L33-L39 (1 Aug 1975).

The reaction $^{36}$Ar ($\alpha$, p$\gamma$)$^{39}$K has been used to measure angular distributions, linear polarizations, mixing ratios, branching ratios and mean lifetimes for a number of high spin states in $^{39}$K. The results give the following unambiguous spin and parity assignments: $E_x$ $J^\pi$; 2814 keV $\frac{7}{2}^-$; 3597 keV $\frac{9}{2}^-$; 3944 keV $11/2^-$; 5718 keV $\frac{9}{2}^-$ and 6475 keV $11/2^+$. Using a solid $^{36}$Ar target and the Doppler shift attenuation method a mean lifetime of 250 ± 65 fs has been measured for the 5718 keV level. There are several discrepancies between the present results and the results of previous work. (auth)

**29750** THE PROTON CHANNEL IN MUON CAPTURE BY $^{32}$S. Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Majling, L.; Rizek, J. (Ustav Jaderne Fyziky, Rez (Czechoslovakia)). Nucl. Phys., A; 247: No. 3, 411-417(11 Aug 1975).

A possibility for proton emission after muon capture by $^{32}$S is discussed in the resonance mechanism approach. The branching ratios and neutron spectrum are calculated. It is shown that the proton emission can be reasonably described in terms of the model used. (auth)

**29751** THE MULTI-STEP EFFECTS IN THE $^{16}$O-$^{17}$O ELASTIC AND INELASTIC CORE EXCHANGE SCATTERING. Imanishi, B.; Tanimura, O. (Nihon Univ., Tokyo. Dept. of Physics); Onishi, H. (Hosei Univ., Tokyo (Japan)). Phys. Lett., B; 57: No. 4, 309-312 (21 Jul 1975).

The strong multi-step transfer effects, due at least to the three-step transfer are found in the coupled channels analyses of $^{17}$O($^{16}$O, $^{16}$O) $^{17}$O (ground- and first excited $\frac{1}{2}^+$ states). The shallow optical potential with "weak" imaginary part is shown to be well applicable to these scatterings if the multi-step processes are taken into account. (auth)

## Nuclear Properties and Reactions, 39 ≤ A ≤ 58

*Refer also to abstracts 29670, 29674, 29683, 29685, 29691, 29721, 29724, 29727, 29749, 29898, and 29958.*

**29752** FINE STRUCTURE OF ANALOGUE STATES IN $^{45}$Sc. Wilson, W. M.; Bilpuch, E. G.; Mitchell, G. E. (Triangle Universities Nuclear Lab., Durham, N. C. (USA)). Nucl. Phys., A; 245: No. 2, 262-284(30 Jun 1975).

Differential cross sections were measured for $^{44}$Ca(p,p) and $^{44}$Ca(p,p') at four angles between $E_p$ = 1.5 and 3.0 MeV, with an overall energy resolution of about 325 eV. Spins, parities, total and partial widths were extracted for 429 resonances. Five analogue states were identified and fits to the fine structure were obtained for four of these analogues. (auth)

**29753** APPLICATIONS OF STATISTICAL TESTS TO PROTON RESONANCES IN $^{45}$Sc AND $^{49}$V. Wilson, W. M.; Bilpuch, E. G.; Mitchell, G. E. (Triangle Universities Nuclear Lab., Durham, N. C. (USA)). Nucl. Phys., A; 245: No. 2, 285-305(30 Jun 1975).

Several statistical tests have been applied to $\frac{1}{2}^-$ and $\frac{1}{2}^+$ proton resonances observed in $^{44}$Ca(p,p) and to $\frac{1}{2}^+$ resonances observed in $^{48}$Ti(p,p). The energy dependence of the density was unfolded

(to a constant density) in order to make comparison with theoretical spacing predictions for single level populations. The functional form for the density does not appear to significantly affect the results: a constant temperature density function was adopted for simplicity. The $^{44}$Ca data overall indicate missing and spurious levels. However for a sub-section of these data, where the observed total number of resonances of all spins and parities is relatively lower, and where the effects of $1/2^+$ and $1/2^-$ analogue states enhance the widths, the data appear nearly complete. For $52\,1/2^-$ levels in $^{45}$Sc, $\Delta_3^{exp} = 0.39$ ($\langle\Delta_3\rangle$ (correlated) = 0.35) and $\rho^{exp}(S_i,S_{i+1}) = -0.32$ ($\langle\rho\rangle$(correlated) $= -0.27$). For $39\,1/2^+$ levels in $^{45}$Sc, $\Delta_3^{exp} = 0.34$ ($\langle\Delta_3\rangle$(correlated) = 0.35) and $\rho^{exp} = -0.35$ ($\langle\rho\rangle$(correlated) $= -0.28$). For $^{49}$Ti all of the $1/2^+$ levels were included. For $66\,1/2^+$ levels in $^{49}$V, $\Delta_3^{exp} = 0.51$ ($\langle\Delta_3\rangle$(correlated) = 0.38) and $\rho^{exp} = -0.21$ ($\langle\rho\rangle$ (correlated) $= -0.27$). Dyson's F-statistic test was applied to all of these data, and the $\kappa$th nearest spacing distributions were calculated for $\kappa = 0$ through 10. All of these results appear internally consistent. There is thus strong evidence for both short and long range correlations in the spacings of single level populations observed by proton resonance reactions. These results are consistent with the first experimental demonstration of such correlations by the Columbia group in total neutron cross section measurements. (auth)

**29754** (T,P) REACTION ON $^{36\,38\,40}$Ar. Flynn, E. R.; Hansen, O.; Casten, R. F.; Garrett, J. D. (Los Alamos Scientific Lab., N. Mex. (USA)); Ajzenberg-Selove, F. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). Nucl. Phys., A; 246: No. 1, 117-140(14 Jul 1975).

The $^{36,38,40}$Ar(t,p) reactions have been investigated at 20 MeV incident energy with an energy resolution of ~35 keV FWHM. Proton spectra were measured at seven angles from 12.5° to 57.5°. The differential cross sections were analyzed by distorted wave calculations and values of the transferred orbital momentum were assigned for many transitions. A discussion of the observed cross sections for L = 0 transitions leads to the conclusion that the role of the pairing force in the Ar isotopes is midway between a vibrational and a super-fluid case. It is demonstrated through an analysis of the low-lying $0^+ \rightarrow 2^+$ transitions that the extra degree of freedom, associated with the two proton holes, mixes with the neutron shell model and the multi-particle degrees of freedom. (auth)

**29755** NEGATIVE PARITY STATES OF THE CROSS-CONJUGATE NUCLEI $^{47}$V–$^{49}$Cr, $^{47}$Ti–$^{49}$V IN THE STRONG COUPLING MODEL. Haas, B.; Taras, P.; Styczen, J. (Centre National de la Recherche Scientifique, 67- Strasbourg (France). Lab. de Physique du Noyau et de Physique des Particules). Nucl. Phys., A; 246: No. 1, 141-155(14 Jul 1975).

Band mixing calculations treating more correctly the $j^2$ term and hole excitations have been undertaken on the cross-conjugate nuclei $^{47}$V-$^{49}$Cr and $^{47}$Ti-$^{49}$V. There is an overall good agreement between the experimental data and the theoretical predictions. In particular, the states whose configurations arise mainly from the ground state orbit are, in general, quite well reproduced. These include the known high spin states up to $I^\pi = 17/2^-$. (auth)

**29756** GAMMA DECAY OF HIGH SPIN STATES OF $^{39}$K. Uhrmacher, M.; Dauk, J.; Wuest, N.; Lieb, K. P. (Koeln Univ. (F. R. Germany). Inst. fuer Kernphysik); Kleinfeld, A. M. (Koeln Univ. (F. R. Germany). 1. Physikalisches Inst.). Z. Phys., A; 272: No. 4, 403-411(1975).

6 figs.; 4 tabs.; 36 refs.

The decays of high spin states in $^{39}$K, populated in the reactions $^{28}$Si($^{16}$O,$\alpha$p) and $^{25}$Mg($^{16}$O,pn), have been measured for oxygen beam energies between 30 and 50 MeV. Using the recoil distance Doppler shift method, mean lifetimes were determined for the states at 2,814 keV ($\tau = 62 \pm 5$ ps), 3,597 ($51 \pm 4$ ps), 3,943 ($11.4 \pm 1.6$ ps), 4,830 ($19 \pm 5$ ps), 5,715 (< 3 ps), 6,473 ($11.9 \pm 0.5$ ps), and 8,028 ($10 \leq \tau \leq 50$ ps), respectively. Possible spin assignments and transition rates for these levels will be discussed. (auth)

**29757** INVESTIGATION OF THE ($^3$He,n) REACTION AT 25.4 MeV. Fielding, H. W. Laramie, WY; University of Wyoming (1974). 244p. University Microfilms Order No. 75-12,830.

Thesis (Ph. D.).

Angular distributions have been measured for the ($^3$He,n) reaction on targets of $^{46,48}$Ti, $^{56,57}$Fe, $^{60}$Ni, $^{64,68}$An, $^{70,72}$Ge, $^{88}$Sr, $^{90,92,94}$Zr, $^{112,114}$Cd and $^{112,116,118,120,124}$Sn with a bombarding energy of 25.4 MeV. The energy resolution was around 500 KeV, for the fastest neutrons, which was sufficient to resolve low lying excited states. The angular distributions extended between $0^0$ and $90^0$ for the (f,p) shell nuclei and from $0^0$ to $30^0$ for the higher A nuclei. The distorted wave Born approximation (DWBA) theoretical predictions were investigated for the (f,p) shell nuclei. The results for the ground state and low lying level transitions were quite good for the lighter f,p shell nuclei but the agreement was poor for the higher mass nuclei. The DWBA calculations failed to show the observed trend in the experimental results of the first minima becoming less and less pronounced as the mass increased. The predictions of pairing vibrational theories for (f,p) shell nuclei were quite good around the Z equals 28 closed shell but were poor for those Cr isotopes investigated. The weak coupling model was investigated for the L equals 0 transitions observed in the $^{56,57}$Fe($^3$He,n)$^{58,59}$Ni reactions. The agreement was excellent for both of the observed transitions although a splitting of the low lying L equals 0 transition in $^{59}$Ni was observed. The Zr and Sr targets showed the selectivity expected for these reactions far from closed shells in that the ground state transitions were greatly enhanced over all others. Many proton configurations were shown to be active for the N equals 50 nuclei. The (t,p) and ($^3$He,n) reactions around N equals 50 and Z equals 50 show the same fragmentation of the excited pairing vibrational state. However, in contrast the ($^3$He,n) reaction near Z equals 50 also shows low lying $0^+$ states which may imply the "co-existence of spherical and deformed states" around the Z equals 50 closed shell. (Diss. Abstr. Int., B)

**29758** HIGHER-ORDER AND ATOMIC EFFECTS IN THE DECAY OF NUCLEI AND THEIR INTERDISCIPLINARY RELATIONS. Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary). Magy. Fiz. Foly.; 22: No. 6, 569-594(1974). (In Hungarian).

In view of the continued disappearance of sharp boundaries between various branches of science, the specifically interdisciplinary results of the research carried out are reviewed. Work on internal bremsstrahlung and on nuclear atomic effects reported, detail. Results from the study of the decay of $^{11}$C and $^{32}$P on bremsstrahlung effect are considered; work is still in progress in this area on $^{35}$S and $^{36}$Cl nuclei. Valuable data were obtained from the study of electron capture and internal conversion of $^{22}$Na, $^{36}$Cl, $^{54}$Mn, $^{55}$Fe, $^{56}$Co, $^{59}$Ni, $^{74}$As, $^{110}$Ag, $^{113}$Sn, $^{131}$I, $^{139}$Ce, $^{143,\,144,\,146}$Pm, by means of a variety of instrumental techniques, such scintillation and semiconductor devices in double and triple coincidence arrangement. Chemical effects were studied by investigating the attachment of iodine onto various metallic surfaces, using $^{125}$I and $^{131}$I, in view of the fact that the conversion probability of the external shell affects the results. A radioisotopic x-ray fluorescence method was also developed to determine the Ca content of bauxite; this is an important factor in the manufacture of alumina. (Inaugural presentation at the Hungarian Academy of Sciences) (TTT)

**29759** ANOMALIES IN $\alpha$ SCATTERING AND ($^3$He,$\alpha$) REACTIONS ON $^{40,41}$Ca AND THE EFFECT OF CLUSTER EXCHANGE. Apell, H. J.; Gemeinhardt, W.; Stock, R. (Marburg Univ. (F. R. Germany). Fachbereich Physik); Betts, R. R.; Hansen, O.; Sperduto, A. (Niels Bohr Institutet, Copenhagen (Denmark)); Fuchs, H. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F. R. Germany)); Santo, R. (Muenster Univ. (F. R. Germany). Inst. fuer Kernphysik). Nucl. Phys., A; 246: No. 2, 477-489(21 Jul 1975).

Elastic $\alpha$-scattering angular distributions have been measured on $^{40,41}$Ca at 19, 24.1 and 26.5 MeV. Both isotopes exhibit anomalous backward scattering cross sections at all three energies. Anomalies are also found in the forward-angle cross sections for $^{40,41}$Ca($^3$He,$\alpha$) reactions, measured for six final states at incident $^3$He energies varied in steps of 1 MeV between 16 MeV and 27 MeV. The appearance of these anomalously high cross sections can be qualitatively understood to arise from cluster substitution and exchange mechanisms acting both in elastic $\alpha$-scattering and in the ($^3$He,$\alpha$) reaction. (auth)

**29760** GIANT RESONANCES IN f–p SHELL NUCLEI STUDIED BY INELASTIC SCATTERING OF 80 MeV $^3$He IONS. Arvieux, J.; Buenerd, M.; Cole, A. J.; de Saintignon, P.; Perrin, G.; Horen, D. J. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). Nucl. Phys., A; 247: No. 2, 238-250(4 Aug 1975).

Spectra of $^{48}$Ti, $^{56}$Fe, $^{59}$Co and $^{60}$Ni have been investigated for excitation energies of 10–20 MeV by inelastic scattering of 80 MeV $^3$He particles. Broad peaks with excitation energies of about $63 \pm 1\ A^{-\frac{1}{3}}$ MeV and FWHM of 6 MeV have been observed. Much narrower satellite peaks occur at excitation energies about $51 \pm 1\ A^{-\frac{1}{3}}$ MeV. The angular distributions of the sum of these peaks were compared to extended optical model DWBA calculations, which confirm the predominant L = 2 character of the GR. A tentative assignment of L = 2 or 4 was made for the 13.5 MeV satellite peak in $^{56}$Fe. No definitive evidence is seen for the presence of an L = 1 GR component. (auth)

**29761** DEUTERON OPTICAL MODEL ANALYSIS. Buergi, H. R.; Grueebler, W.; Schmelzbach, P. A.; Koenig, V.; Risler, R. (Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. fuer Kernphysik). Nucl. Phys., A; 247: No. 2, 322-334 (4 Aug 1975).

Differential cross sections and vector and tensor analyzing powers of deuterons elastically scattered by $^{40}$Ar, $^{40}$Ca and $^{60}$Ni have been analyzed in terms of an optical potential containing tensor terms. The effect of two optical potential tensor terms on the various analyzing power components has been investigated. It was found that the quantity $T_{20}$ at 180° is particularly sensitive to the optical potential tensor parameters. Although the differential cross section and the vector analyzing power data were already well reproduced without any tensor interactions in the optical potential, the inclusion of tensor terms improved greatly the fits to the tensor analyzing power data, resulting in a fairly satisfactory agreement. (auth)

**29762** STRUCTURE OF LOW-LYING LEVELS IN $^{56}$Ni. Sharma, S. K. (International Centre for Theoretical Physics, Trieste (Italy)). Phys. Lett., B; 57: No. 3, 210-212(7 Jul 1975).

It is shown possible to understand the structure of the low-lying states in the nucleus $^{56}$Ni, in a simple way, in terms of the Hartree–Fock intrinsic states resulting from the Kuo–Brown effective interaction for the 2p–1f shell, modified slightly so as to satisfy certain constraints imposed on it by the B(E2) (0 → 2) systematics in the shell. (auth)

**29763** ANALYTIC THEORY OF DOPPLER-SHIFT ATTENUATION. Winterbon, K. B. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Nucl. Phys., A; 246: No. 2, 293-316(21 Jul 1975).

The treatment of the author's earlier exact analysis of Doppler shifts of γ-spectra is improved. The analysis remains exact within the Lindhard theory of slowing down of heavy ions in solids, while calculations using a realistic scattering cross section and including electronic stopping are facilitated. Besides the first moment, $F(\tau)$, of the Doppler-shifted spectrum, higher moments of the spectrum and the spectrum itself can be calculated. It is pointed out that the cumulative spectrum—i.e., the indefinite integral of the spectrum—is more easily and reliably calculated than the spectrum itself. Comparisons are made with calculations by the Blaugrund method and with experiment. (auth)

**29764** ANALYSIS OF THE SCATTERING OF 6 MeV PROTONS BY $^{58}$Fe. Antropov, A. E.; Dolgintseva, A. I.; Zarubin, P. P.; Ioannu, P. D.; Kabakova, N. E.; Orlov, B. N. (Leningrad State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 108-112 (1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2585-2590(1974).

An analysis is reported of elastic and inelastic scattering of 6 MeV protons by $^{58}$Fe within the framework of the distorted-wave and coupled channels theories with allowance for scattering through the compound nucleus. Calculations based on the coupled-channels method were carried out with different assumptions with regard to the nature of low-lying levels in $^{58}$Fe. The best agreement is achieved for the Davydov model. The deformation parameter $\beta_2$ deduced from these calculations turns out to be 0.24 ± 0.03. (3 figures) (auth)

**29765** γ-RAY SPECTRUM FROM THE $^{49}$Ti(p,nγ)$^{49}$V. Antropov, A. E.; Aleksandrov, Yu. A.; Gandarias, D. R.; Zarubin, P. P.; Ioannu, P. D. (Leningrad State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 40-44(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR(29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2511-2515(1974).

The γ-ray spectrum from the $^{49}$Ti(p,nγ)$^{49}$V reaction at a proton energy of 6 MeV has been examined up to a γ-ray energy of 3.3 MeV, and 63 lines have been identified. The possibility of describing the low-lying states of 49V in terms of the weak coupling model is analyzed. (2 figures, 1 table) (auth)

**29766** ANALYSIS OF HIGH ENERGY HEAVY-ION TRANSFER REACTIONS. Scott, D. K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). pp 165-193 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

The regions of validity of quantal and semiclassical theories are discussed for high energy transfer reactions with heavy ions. After demonstrating the equivalence of the two formalisms, they are applied quantitatively to predict spectroscopic factors, the energy dependence and Q dependence of single nucleon transfer on lead. The power of semiclassical theory for making wide surveys is shown. The nuclei are discussed using semiclassical theory. Finally the quantal analysis of new effects due to multi-step processes in high energy heavy-ion reactions is presented. (auth)

**29767** EVIDENCE FOR THE TEMPORARY EXISTENCE OF A "COMPOSITE" SYSTEM IN DEEP INELASTIC NUCLEAR INTERACTIONS. Gatty, B.; Guerreau, D.; Lefort, M.; Pouthas, J.; Tarrago, X.; Galin, J. (Paris Univ., 75 (France). Inst. de Physique Nucleaire); Cauvin, B.; Girard, J.; Nifenecker, H. (CEA Centre d'Etudes Nucleaires de Saclay, 91- Gif-sur-Yvette (France). Dept. de Physique Nucleaire). Z. Phys., A; 273: No. 1, 65-68 (May 1975).

4 figs.; 2 tabs.; 12 refs.

Masses and charges were identified for the light fragments ($6 < A < 40$) produced in the reactions ($^{40}$Ar + $^{58}$Ni), ($^{40}$Ar + $^{64}$Ni), ($^{40}$Ca + $^{58}$Ni) and ($^{40}$Ca + $^{64}$Ni). From the study of N and Z distributions, it was shown that the ratio N/Z of the composite system has a dominant role in the determination of the N/Z of the product. Then there should be at least a charge equilibration during the damped collision. (auth)

# Nuclear Properties and Reactions, 59 ≤ A ≤ 89

*Refer also to abstracts 29656, 29691, 29741, 29757, 29758, and 29767.*

**29768** (INIS-mf-1686) IMPROVEMENT OF THE STATISTICAL MODEL FOR COMPOUND NUCLEUS DECAY AT LOW EXCITATION ENERGIES. Submitted in Partial Fulfillment of the Requirements of the Master's Degree in the Department of Chemistry, Bar-Ilan University. Segal, L. (Bar-Ilan Univ., Ramat-Gan (Israel)). Aug 1974. 115p. (In Hebrew). INIS.

In theoretical calculations of compound nucleus decay caused by particles or radiation, it has been customary to include the concept of level densities for residual nuclei, even at low energies where it is known that there exist well defined levels. Until now, comparison between the observed and calculated spectra was limited to that part of the spectrum which is "Maxwellian" in form, and disregard the discrete spectra. This kind of comparison leads to certain conclusions about the character of compound nucleus decay in the region of low excitation energies. The aim is to check the results theoretically and to again test the statistical model for compound-nucleus decay, at low excitation energy, by including decay to discrete levels in all possible channels of the reaction. A computer code for calculating the energy spectrum of decaying particles and reaction cross sections was written. In order to check the improvement suggested on the statistical model, the decay of the compound nucleus $^{63}$Cu at an excitation energy of 18.06 MeV was calculated by the program. It was found that not only is the discrete region of energy specific for every nucleus, but so is the lowest continuum region, which is 2 to 3 MeV higher. It was found that this latter region is very sensitive to the behavior of the level densities of the nucleus with which one is dealing. The Fermi gas model formulas, which can be applied for higher continuum regions, cannot be used to describe the level densities in the lower continuum region in every case. In the compound nucleus decay at low excitation energies, not only must the discrete level in the different residual nuclei be considered, but also the specific behavior of level densities at the low continuum. Calculations for decay in the compound nucleus $^{63}$Cu, which take these facts into consideration, give results for energy spectra and cross sections, which are in good agreement with the experimental results. (BG)

**29769** PERTURBED ANGULAR DISTRIBUTION IN $^{70}$Ga. Hutcheon, D. A.; Sheppard, D. M.; Kitching, P.; Davidson, J. M.; Luursema, C. W. (Alberta Univ., Edmonton (Canada). Nuclear Research Centre); Carlson, L. E. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Nucl. Phys., A; 245: No. 2, 306-316(30 Jun 1975).

A pulsed proton beam and coaxial Ge(Li) detector were used to study the time dependence of the angular distribution of γ-rays resulting from the decay of the 879 keV state in $^{70}$Ga, as excited by the $^{70}$Zn(p,n)$^{70}$Ga reaction. A strong time-dependent attenuation of anisotropy was observed. The unperturbed value of the angular distribution is consistent with the assignment of spin I = 4 to the 879 keV level. The half-life of the 879 keV state was measured to be $T_{\frac{1}{2}} = 22.7 \pm 0.5$ ns. (auth)

**29770** PROTON SPECTROSCOPY OF $^{85,88}$Sr VIA ($^3$He, d). Schneider, M. J.; Anderson, R. E.; Brabeck, P. G. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.). Nucl. Phys., A.; 246: No. 1, 156-172(14 Jul 1975).

The $^{85,87}$Rb($^3$He, d)$^{86,88}$Sr reactions have been studied at 33.3 MeV incident energy. Angular distributions for eighteen $^{86}$Sr levels and ten $^{88}$Sr levels over an angular range $2.5° \leq \Theta_{lab} \leq 45°$ were taken in the University of Colorado energy-loss spectrometer. Two recent prescriptions for ($^3$He, d) DWBA calculations were

compared with the data. Whichever prescription is used, qualitative results are unchanged: the $^{87}$Rb ground state has less than 0.5 f-holes and about 2 p-holes for protons, while $^{85}$Rb has about 1 p-hole and 2 f-holes, and hence is not well described as a single-proton hole. This indicates that the two $g_{\frac{9}{2}}$ neutron holes in $^{85}$Rb prevent good closure of the 1f proton shell, in spite of the fact that in this nucleus neutron excitations do not mix appreciably with proton excitations. (auth)

**29771** LEVEL STRUCTURE OF $^{75}$As. McMurray, W. R. (Southern Universities Nuclear Inst., Faure (South Africa)); Celliers, P. J.; Saayman, R. (Stellenbosch Univ. (South Africa). Merensky Instituut vir Fisika). Nucl. Phys., A; 225: No. 1, 37-54(4 Jun 1974).

Neutron inelastic scattering has been used to excite levels in $^{75}$As. The de-excitation gammas have been observed for incident neutron energies up to 2200 keV. Time-of-flight neutron measurements were made for incident neutron energies up to 1350 keV. The energy levels and decay modes of $^{75}$As were deduced and the (n, n') cross sections to each level were measured. Spin and parity assignments are based on a comparison with Hauser–Feshbach calculations and other work on this nucleus. The deduced level structure is compared with theoretical predictions of phenomenological models in which a single particle is coupled to a vibrational or rotational core. (auth)

**29772** (p,d) REACTION ON THE GERMANIUM ISOTOPES. Show, D. L. East Lansing, MI; Michigan State University (1974). 142p. University Microfilms Order No. 75-14,825.

Thesis (Ph. D.).

States in $^{69}$Ge, $^{71}$Ge, $^{73}$Ge, $^{75}$Ge and $^{75}$Ge have been studied with the (p,d) reaction at a proton energy of 35 MeV. Deuterons were analyzed with an Enge split-pole magnetic spectrograph and detected in nuclear emulsions with an energy resolution of about 8 keV FWHM. Excitation energies were measured relative to a calibration calculated from the known characteristics of the spectrograph and previously well established excited state energies in the various nuclei. The resulting uncertainties were about 1.5 keV per MeV excitation. Angular distributions were measured between the angles of 6° and 60°. l-Transfer and spectroscopic factors were extracted by normalizing DWBA calculations to the angular distributions. These data allow the assignment of some spins and parities for the final states and the determination of the amount of filling of the active shell model orbits in the target nuclei. (auth)

**29773** STUDY OF THE $^{58}$Ni(p,γ)$^{59}$Cu REACTION. Trentelman, J. P.; Cooke, B. E.; Leslie, J. R.; McLatchie, W.; Robertson, B. C. (Queen's Univ., Kingston, Ontario (Canada). Dept. of Physics). Nucl. Phys., A; 246: No. 2, 457-476(21 Jul 1975).

Eleven resonances in the reaction $^{58}$Ni(p,γ)$^{59}$Cu have been investigated in the proton energy region $0.9 \leq E_p < 2.3$ MeV. Gamma-ray angular distribution measurements on six resonances yield the following resonance spins ($E_p$(keV); J): (1376; 3/2), (1424; 3/2), (1833; 5/2, 9/2), (1883; 3/2), (2238; 7/2), (2275; 5/2). In addition spins of several low-lying levels were determined (or limited). They are ($E_x$(keV); J): (1398; 7/2), (1865; 7/2), (1987, 5/2), (2265; 3/2), (2318; (1/2)), (2324; 3/2), (2663; 5/2, 9/2), (2707; 5/2), (2714; 7/2), (2927; 5/2), (3022; 5/2, 7/2), (3025; (3/2)), (3114; (5/2)), (3130; (3/2)), (3434; (5/2)), (3438; (1/2)), (3615; 3/2), (3663; 1/2, 3/2), and (4181; 5/2, 7/2). Previously unreported states have been observed at $E_x$ = 2663, 2707, 3022, 3025, 3114, 3438, 3742 and 4181 keV. Branching ratios and multipole mixing ratios have been measured for the decay of several bound levels, and these results are compared with recent theoretical calculations. Four of the resonances studied have been identified as isobaric analogues of low-lying $^{59}$Ni levels. As well, the γ-decay of the (presumed) $^{59}$Ni g.s. analogue at 3905 keV has been observed. The log ft values for the $\beta^+$ decay of $^{59}$Cu to various $^{59}$Ni states are calculated from measured γ-widths in analogue state decay and are compared to values measured in $\beta^+$ decay. (auth)

**29774** CORE EXCITATION EFFECTS IN THE INELASTIC DECAY OF ISOBARIC ANALOG RESONANCES IN $^{89}$Y. Ramavataram, K.; Larue, R.; Sharma, T. C.; St-Pierre, C.; Ramavataram, S. (Laval Univ., Quebec City (Canada). Dept. de Physique). Nucl. Phys., A; 247: No. 1, 139-151(28 Jul 1975).

The measured excitation functions and angular distributions of four analog resonances excited in the $^{88}$Sr(p,p')$^{88}$Sr* reaction are compared with a resonance calculation that includes contributions from the direct excitation of the $2^+$(1.84 MeV) core state. The experimental results are well reproduced by these calculations, and the spectroscopic factors thus extracted are compared with those predicted by a particle–core coupling model. In all the cases studied, the present analysis shows that the distorted-wave Born approximation provides a good description of the direct excitation mechanism. (auth)

**29775** STROBOSCOPIC OBSERVATION OF QUADRUPOLE HYPERFINE INTERACTIONS. Schatz, G.; Brenn, R.; Fossan, D. B. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). Phys. Lett., B; 57: No. 3, 231-234(7 Jul 1975).

A stroboscopic technique for the observation of quadrupole hyperfine interactions of isomeric nuclear states has been successfully developed. The inherent precision and resolution of this technique have been demonstrated by measuring the quadrupole hyperfine frequency for $^{69}$Ge($9/2^+_1$, $\tau$ = 4.0 μs) in Zn metal at several temperatures: $\omega_0 = [19.67 \pm 0.06] \times 10^6$ s$^{-1}$ (at 623 ± 3 K). (auth)

**29776** UNIQUE FIRST-FORBIDDEN β-DECAY OF $^{86}$Rb. Behrens, H.; Kobelt, M.; Szybisz, L.; Thies, W. G. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Nucl. Phys., A; 245: No. 3, 515-527 (7 Jul 1975).

The spectrum shape of the $2^- - 0^+$ unique first-forbidden β-transitions of $^{86}$Rb has been remeasured. An end-point energy of $E_0$ = 1779.2 ± 2.5 keV and a shape factor coefficient $a = -0.039 \pm 0.003(m_0c^2)^{-1}$ have been obtained. In order to explain this deviation from the unique forbidden shape a detailed theoretical analysis of this β-transition has been carried out. It was found that it is not possible to explain this behavior in the framework of the unified model. By including, however, the induced currents, especially the induced tensor current (second-class current), in the on-mass-shell limit, more agreement between experiment and theory could be obtained. But the extracted value for the induced tensor coupling constant $f_T$= 0.013 ± 0.005 should be considered as a rough estimate only because of the simplistic nature of the analysis in single-particle impulse approximation terms. (auth)

**29777** MEASUREMENT AND ANALYSIS OF THE ELASTIC PROTON CROSS SECTIONS OF $^{89}$Y AND $^{93}$Nb IN THE ENERGY RANGE BETWEEN 5 AND 6 MeV. Romanovskii, E. A.; Sirotinin, E. I.; Spasskaya, T. I.; Shishkin, K. S.; Gubin, V. B.; Rudnev, A. S. (Moscow State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 87-90(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR(29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2562-2566(1974).

Measurements are reported of the energy and angular dependence of the elastic proton cross sections of $^{89}$Y and $^{93}$Nb for proton energies between 5.2 and 6.3 MeV. The possibility is investigated of describing the angular distributions, measured at nonresonant energies, within the framework of the optical model, using a single set of parameters. (5 figures) (auth)

**29778** GIANT ISOSCALAR QUADRUPOLE RESONANCES. Gul'karov, I. S. (Tashkent Polytechnical Inst.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 157-162(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2642-2647 (1974).

The giant isoscalar quadrupole resonance is studied in the isotopes $^{58}$Ni, $^{60}$Ni, $^{64}$Ni, and the properties of this resonance are discussed in the case of electron, proton, and $^3$He scattering by nuclei. (6 figures) (SDF)

**29779** MEASUREMENT OF THE ELECTRON CAPTURE OF $^{70}$Ga. Burmester, U. (Goettingen Univ. (F. R. Germany). 2. Physikalisches Inst.). Z. Phys., A; 273: No. 1, 85-87(May 1975). (In German).

2 figs.; 9 refs.

The electron capture of $^{70}$Ga was observed using an x-ray semiconductor Ge(Li) detector. Measuring the Zn K x-rays and the 0.1755-MeV gamma-rays from the beta decay of $^{70}$Ga the transition probability to the ground state of $^{70}$Zn was found to be 0.24%. The log(ft) value is 4.8. The half-life of $^{70}$Ga was found to be (21.15 ± 0.06)min and the energies of the gamma-rays are (0.1755 ± 0.0005) MeV and (1.040 ± 0.003) MeV. (auth)

**29780** THEORETICAL INTERPRETATION OF THE NUCLEAR STRUCTURE OF THE DOUBLY-EVEN N = 84 NUCLEI. Vanden Berghe, G. (Ghent Rijksuniversiteit (Belgium). Seminarie voor Wiskundige Natuurkunde). Z. Phys., A; 272: No. 3, 245-256 (Mar 1975).

6 figs.; 5 tabs.; 33 refs.

The nuclear structure of the doubly-even N = 84 nuclei was explained in terms of the two-particle core coupling model. The positive parity states are studied in a diagonalization treatment, while the negative parity states are treated in a perturbation approach. Theoretical spectroscopic factors for a $^{143}$Nd(d,p) reaction are compared with experimental data. Electromagnetic properties are calculated and some of them (electric quadrupole moment, reduced E3 transition probability) are analyzed by means of perturbation theory. (auth)

# Nuclear Properties and Reactions, 90 ≤ A ≤ 149

*Refer also to abstracts 29689, 29691, 29722, 29729, 29757, 29758, 29777, and 29968.*

**29781** (HU-P-78) LEVEL STRUCTURE OF $^{157}$Tb FROM THE DECAY OF $^{157}$Dy. Pukakka, P. (Helsinki Univ. (Finland). Dept. of Physics). 1974. 68p. Dep. NTIS (US Sales Only) $6.50.

The electron capture decay of $^{157}$Dy to excited states in $^{157}$Tb has been investigated by using Ge(Li) and Si(Li) detectors and detector combinations. The activity was produced through the $^{159}$Tb(p,3n) $^{157}$Dy reaction with 25 and 30 MeV protons. Most of the sources used were mass separated. Gamma-ray energies and relative intensities were determined for 45 transitions assigned to the decay of $^{157}$Dy. The constructed decay scheme of $^{157}$Dy contains 17 energy levels in $^{157}$Tb. Most of them are established by gamma–gamma coincidence data recorded with a two-parameter coincidence system utilizing two Ge(Li) detectors. The K conversion coefficient of the intense 326 keV transition was measured to be 0.0122 ± 0.0008. From the relative electron and gamma-ray intensities the K conversion coefficients were calculated for several other transitions. Spin and parity assignments based mainly on deduced transition multipolarities are proposed. A value of 7.96 ± 0.05 h was obtained for the half-life of $^{157}$Dy. The lifetimes, gamma-ray branching rations and multipole mixing rations were calculated for several low-energy levels and transitions in $^{157}$Tb by using the Nilsson model and including the mixing of single-particle states due to the Coriolis coupling. (auth)

**29782** (JINR-E7-8843) EVALUATION OF ELECTRON AND NUCLEAR BREMMSTRAHLUNG IN HEAVY ION COLLISIONS. Gippner, P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 10p. Dep. NTIS (US Sales Only) $4.00.

The detection of quasimolecular x-ray continua provides the possibility of investigating the electron shells of quasimolecules transiently formed during adiabatic heavy ion-atomic collisions. The contribution of the electronic and nuclear bremsstrahlung to quasimolecular X-ray continua observed in bombarding various targets with 65 and 96 MeV Nb ions were estimated. (4 figures, 1 table) (auth)

**29783** (JINR-P1-9083) INVESTIGATIONS OF THE EMISSION INTENSITY OF $\pi^0$ MESONS IN INTERACTIONS OF FAST $\pi^+$ MESONS WITH ATOMIC NUCLEI. Miller, K.; Pluta, Ya.; Peryt, W.; Strugal'skii, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1975. 19p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Experimental investigation of the emission process of $\pi^0$ mesons in interactions of fast $\pi^+$ mesons with xenon nuclei is done. The analysis of the experimental data and the comparison of experimental results with the corresponding models are performed. (auth)

**29784** (JU-RR-75/2) MIXING OF THE TRANSITIONS FROM THE 3$^+$ QUASI γ-BAND LEVEL IN $^{152}$Gd. Helppi, H.; Pakkanen, A.; Hattula, J. (Jyvaeskylae Univ. (Finland). Dept. of Physics). Mar 1975. 11p. Dep. NTIS (US Sales Only) $4.00.

The directional correlation method was used to determine multipole mixing rations of some γ-transitions in $^{152}$Gd. The 678.6 and 1089.8 keV γ-rays from the 3$^+$ quasi γ-band level were observed to be almost pure E2 transitions, which is in disagreement with earlier results. The B(E2) rations of the transitions from this level are consistent with theoretical calculations. (3 figures, 3 tables) (auth)

**29785** (JR-RR-75/3) DECAY OF 14.6 h $^{90}$Nb. Pakkanen, A.; Kortelahti, M.; Helppi, H.; Kantele, J.; Poikolainen, T.; Komu, R. (Jyvaeskylae Univ. (Finland). Dept. of Physics). Mar 1975. 10p. Dep. NTIS (US Sales Only) $4.00.

The disintegration of 14.6 h $^{90}$Nb produced by bombarding natural Zr with 13 MeV protons was investigated by methods of γ-ray spectrometry. Results from singles, coincidence and anti-Compton spectrometer measurements are reported. A decay scheme is proposed including excited states in $^{90}$Zr at 1761, 2186.4, 2319.1, 2739.4, 2747.9, 3077.0, 3448.2, 3589.5, 3977.1, 4232.4, 4319.5, 4375.4, 4541.6, 5060.0, 5164.6, and 5432.9 keV. Over 10 γ-ray transitions and several levels proposed in an earlier investigation are shown to be in error. (auth)

**29786** (ORNL-TM-4972) Nb(n,xγ) REACTION CROSS SECTION FOR INCIDENT NEUTRON ENERGIES BETWEEN 0.65 AND 20.0 MeV. Dickens, J. K.; Morgan, G. L.; Newman, E. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 52p. (ENDF-219). Dep. NTIS $5.45.

Differential cross sections for the neutron-induced gamma-ray production from niobium have been measured for neutron energies between 0.65 and 20 MeV. The Oak Ridge Electron Linear Accelerator (ORELA) was used to provide the neutrons and a NaI spectrometer to detect the gamma rays at 90$^0$. The data presented are the double differential cross section for gamma-ray energies between 0.75 and 10.5 MeV and coarse intervals in the incident neutron energy. The integrated yield of gamma rays of energies greater than 0.75 MeV and higher resolution in the incident neutron energy is also presented. The experimentally determined results are compared with the Evaluated Neutron Data Library (ENDL). (auth)

**29787** $^{136}$Nd DECAY AND THE $^{136}$Pr GROUND STATE SPIN. Brosi, A. R.; Ketelle, B. H. (Oak Ridge National Lab., Tenn. (USA)). Nucl. Phys., A; 245: No. 2, 243-254(30 Jun 1975).

The decay properties of 50.65 min $^{136}$Nd have been studied. It was produced by the $^{136}$Ce($^3$He,3n)$^{136}$Nd reaction and decays by electron capture and positron emission to excited states in $^{136}$Pr. It has a total decay energy of 2211 +- 25 keV. The energies and intensities of 30 gamma-rays have been measured. The K/L conversion ratios of the 149.2 keV and 109.1 keV gamma-rays have been measured to be 7.3 and 7 respectively. The total conversion coefficient of the 40.1 keV gamma-rays was found to be 2.73 +- 0.2. The results of gamma-gamma coincidence measurements together with relative gamma-ray intensities have been used to construct an energy level diagram for $^{136}$Pr. (auth)

**29788** VALENCE COMPONENT IN THE NEUTRON CAPTURE CROSS SECTION OF $^{90}$Zr. Boldeman, J. W.; Allen, B. J.; de L. Musgrove, A. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights); Macklin, R. L. (Oak Ridge National Lab., Tenn. (USA)). Nucl. Phys., A; 246: No. 1, 1-20 (14 Jul 1975).

The neutron capture cross section of $^{90}$Zr has been measured with high energy resolution between 3 and 200 keV using the capture cross section facility at the 40 m station on the Oak Ridge electron linear accelerator. Through the comparison of the present data with the total cross-section and inverse $^{91}$Zr(gamma,n) data from Toohey and Jackson, complete resonance parameters have been extracted for 37 $p^3/_2$, 12 $p^1/_2$ and 11 s-wave resonances out of a total of 101 observed resonances. The neutron strength functions extracted from the resonance parameters are $S_0$ equals 0.56 x 10$^{-4}$, $S_1$ equals 3.8 x 10$^{-4}$, $S_1$ ($p^3/_2$) equals 4.7 x 10$^{-4}$ and $S_1$ ($p^1/_2$) equals 1.9 x 10$^{-4}$. It is noteworthy that the $S_1$ ($p^3/_2$) strength function is significantly larger than the $S_1$ ($p^1/_2$) strength function in agreement with theoretical expectation. A significant correlation (rho equals 0.58) exists between the reduced neutron widths and the radiative widths for the 37 $p^3/_2$ resonances. The data give strong confirmation of the valence neutron model. With standard valence calculations all radiative widths can be calculated reasonably from the associated reduced neutron width. However, to explain the measured correlation coefficient, it has been necessary to include with the valence component, single-particle transitions to the ground and low excited states of $^{91}$Zr, which are uncorrelated with the resonance reduced neutron width. The average capture gamma-spectrum for neutron capture in $^{90}$Zr between 2 and 80 keV has been calculated from the valence model and the present data and is found to be in very close agreement with published experimental data. (auth)

**29789** EXCITATION OF K X-RAYS BY BOMBARDMENT OF THICK SOLID TARGETS WITH 150 MeV Xe IONS. Gippner, P.; Kaun, K. H.; Neubert, W.; Stary, F.; Schulze, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Nucl. Phys., A.; 245: No. 2, 336-342(30 Jun 1975).

The yield of K X-radiation arising from the interaction of $^{136}_{54}$Xe ions with $^{41}$Nb, $^{42}$Mo, $^{45}$Rh, $^{46}$Pd, $^{47}$Ag, $^{48}$Cd, $^{49}$In, $^{50}$Sn, $^{57}$La, $^{64}$Gd, $^{65}$Tb, $^{70}$Yb, $^{71}$Lu, $^{73}$Ta, $^{77}$Ir, $^{78}$Pt, $^{79}$Au and $^{83}$Bi targets was measured Si(Li) and Ge(Li) detectors. The dependence of the yield on the atomic number of the target material is discussed on the basis of the molecular orbital model. (auth)

**29790** BETA-DELAYED ALPHA-PARTICLE EMISSION FROM $^{118,120}$Cs. Hornshoej, P.; Tidemand-Petersson, P. (Aarhus Univ. (Denmark)); Bethoux, R.; Caretto, A. A.; Grueter, J. W.; Hansen, P. G.; Jonson, B.; Hagberg, E.; Mattsson, S. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B.; 57: No. 2, 147-149(23 Jun 1975).

The isotopes $^{118}$Cs($T_{\frac{1}{2}}$ = 16 s) and $^{120}$Cs(58 s) were found to have unresolved, bell-shaped α-particle spectra extending from 7 to 10 MeV and from 6 to 9 MeV, respectively. The branching ratios are (2.4 ± 0.4) × 10$^{-5}$ and (2.0 ± 0.4) × 10$^{-7}$. The experiment confirms $^{120}$Cs to be delayed-proton emitter with a proton branch of (7 ± 3) × 10$^{-8}$. (auth)

**29791** ENERGY SYSTEMATICS OF THE 1g$_{\frac{9}{2}}$ NEUTRON HOLE STATE AND ISOSPIN DEPENDENCE OF THE NUCLEAR POTENTIAL. Ishimatsu, T.; Saito, H.; Yambe, M. (Tohoku Univ., Sendai (Japan). Dept. of Physics); Awaya, T. (Aoyama

Gakuin Univ., Tokyo (Japan). Coll. of Science and Engineering); Ohmura, H. (Faculty of Medicine, Juntendo University, Narashino, Chiba, Japan). Nucl. Phys., A.; 246: No. 1, 21-28(14 Jul 1975).

Energies of $1g_{\frac{9}{2}}$ neutron hole states in several nuclei with neutron numbers between 50 and 82 were measured by means of (p, d) reactions at a proton energy of 52 MeV. These data, together with available data from other studies, are used to obtain the systematics of the single-neutron binding energy of the $1g_{\frac{9}{2}}$ neutron state as a function of neutron and proton number. The depths of a spherical Woods-Saxon potential which reproduce the experimental binding energies are obtained. An expression for the potential depth, which includes an isospin-dependent term, is assumed and the depth of the isospin potential is determined by a least-squares fitting procedure. The results are consistent with those for lighter nuclei obtained by Millener and Hodgson in a similar way. (auth)

**29792** HIGH-SPIN STATES IN THE SINGLE-CLOSED-SHELL NUCLEUS $^{142}$Nd. De Geer, L. E.; Kerek, A. (Research Institute for Physics, 10405 Stockholm 50, Sweden); Haratym, Z.; Kownacki, J.; Ludziejewski, J. (Institute of Nuclear Research. Warsaw (Poland)). Nucl. Phys., A.; 246: No. 1, 104-116(14 Jul 1975).

The excited states of $^{142}_{60}Nd_{82}$ have been studied using the $^{140}$Ce($\alpha$, 2n)$^{142}$Nd and $^{142}$Ce($\alpha$, 4$\gamma$)$^{142}$Nd reactions. Singles $\gamma$-ray, $\gamma$-$\gamma$ coincidence spectra and angular distributions of $\gamma$-rays with respect to the beam direction have been measured. Excited states up to 6.7 MeV with spin values up to 14 are populated. The energy spacings between the lower excited states with spin values up to 8 are similar to those found in the lighter N = 82 even-Z isotones. The majority of the observed states with spin values up to 10 can be explained as two-quasi-particle states. Several of the highest-spin states can be explained qualitatively as four-quasiparticle states. Strong population of the highest excited states (at about 5.7 MeV) is noted, like in other N = 82 isotones. The observed levels in $^{142}$Nd are compared with the shell model predictions using a simple $\delta$-force interaction between two nucleons. (auth)

**29793** YRAST CASCADES IN EVEN-MASS Ce ISOTOPES. Dehnhardt, W.; Mills, S. J.; Mueller-Veggian, M.; Neumann, U.; Pelte, D.; Poggi, G.; Povh, B.; Taras, P. (Heidelberg Univ. (F. R. Germany). 1. Physikalisches Inst.). Nucl. Phys., A.; 225: No. 1, 1-15(4 Jun 1974).

The isotopes $^{130,132,134,136}$Ce are investigated by means of the reactions $^{118,120,122,124}$Sn($^{16}$O, 4n) at bombarding energies between 68 and 76 MeV. From lifetime measurements a reduction of the collective behavior is observed with increasing neutron number. Yrast cascades of rotational structure are identified up to angular momenta $I = 16^+$ or $I = 18^+$ in $^{130,132,134}$Ce. These cascades show a strong " back-bending" effect. In $^{136}$Ce no such simple yrast cascade could be found. (auth)

**29794** MICROSCOPIC CALCULATION OF INELASTIC ELECTRON SCATTERING TO THE FIRST $2^+$ STATE IN SOME EVEN TIN ISOTOPES. Miller, H. G.; Dreizler, R. M. (Frankfurt Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Nucl. Phys., A.; 225: No. 1, 137-140(4 Jun 1974).

A calculation of the inelastic electron scattering form factors to the first excited $2^+$ state in the even $^{116,120,124}$Sn isotopes in the plane wave Born approximation is presented. The states of the even tin isotopes are described in terms of one particle parentage coefficients, which have been obtained self-consistently for the pairing-plus-quadrupole model. The experimentally observed structure of the cross section is well reproduced but the magnitude of the cross section shows the need for a DWBA analysis. (auth)

**29795** GIANT DIPOLE RESONANCE IN THE TRANSITION REGION OF THE SAMARIUM ISOTOPES. Carlos, P.; Beil, H.; Bergere R.; Lepretre, A.; de Miniac, A.; Veyssiere, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Dept. de Physique Nucleaire). Nucl. Phys., A.; 225: No. 1, 171-188(4 Jun 1974).

The evolution of the giant dipole resonance in the transition nuclei $^{144}$Sm, $^{148}$Sm, $^{150}$Sm, $^{152}$Sm, and $^{154}$Sm has been studied by means of a continuously variable monochromatic photon beam which allows one to measure the partial photonuclear cross section [$\sigma(\gamma, n) + \sigma(\gamma, pn)$] and $\sigma(\gamma, 2n)$ separately and simultaneously. Progressive spreading of the dipole strength as Sm nuclei become softer, followed by the ultimate splitting into two distinct dipole modes for $^{152}$Sm and $^{154}$Sm is observed. The evolution of the GDR is tentatively interpreted with different collective models and in particular with an improved dynamic collective model using the potential energy surface concept. (auth)

**29796** INVESTIGATIONS OF ISOMERIC TRANSITIONS IN $^{140}$Pr AND $^{142}$Pr. Schedl, K. H.; Bercks, C.; Hummel, E. (Erlangen-Nuernberg Univ., Erlangen (F. R. Germany). Physikalisches Inst.). Z. Phys., A; 272: No. 4, 417-420(1975). (In German)

6 figs.; 1 tab.; 8 refs.

The lifetimes of isomeric transitions in $^{140}$Pr and $^{142}$Pr have been measured in a pulsed-beam experiment at the Erlangen EN-Tandem accelerator with the aid of the reactions $^{140}$Ce(p,n$\gamma$)$^{140}$Pr and $^{139}$La($\alpha$,n$\gamma$)$^{142}$Pr. In the energy range 50 keV $\leq E_\gamma \leq$ 1.5 MeV we found a new delayed transition in $^{142}$Pr and established two previously reported isomers in $^{140}$Pr. (auth)

**29797** STUDY OF THE PROPERTIES OF NUCLEI STATES FROM TRANSITION REGION NEUTRON-DEFICIENT ISOTOPES OF SAMARIUM. I. Levels $^{145}$Sm Excited at the Decay of $^{145}$Eu. Adam, I.; Amov, B. G.; Batsev, S. K. Bulg. J. Phys.; 11: No. 1, 12-30(1975). (In Russian).

The level structure of $^{145}$Sm was studied by observation of the electron-capture of 5.9-day $^{145}$Eu. The radioactive isotope of $^{145}$Eu was obtained in depth fission reaction by bombarding a Ta or Er target with protons accelerated up to 660 MeV in the synchrocyclotron of the Laboratory for Nuclear Problems in JNRI-Dubna. After chemical separation the Eu-fraction was mass-separated. Both singles and $\gamma$-$\gamma$-coincidence spectra were measured with Ge(Li)-spectrometers. As a result of these measurements more than 20 new transitions were assigned to the decay of $^{145}$Eu. The conversion electron lines were studied by means of magnetic beta-ray spectrometer $2\pi\sqrt{2}$. By combining several sets of conversion-electron and $\gamma$-ray intensities, the K-shell internal conversion coefficients were assigned to a certain number of transitions. From the coincidence data the 1607.1, 1943.6, 2316.9, 2385.5, 2340.5, and 2513.5 keV-levels were established. These levels are compared with some data from $^{144}$Sm (d, p) and $^{144}$Sm (p, n) reaction studies and with a theoretically calculated level scheme by G. V. Berghe and M. Waroquier. (auth)

**29798** STUDY OF THE NUCLEUS $^{107}$Ag IN THE CORE-EXCITATION MODEL WITH THE (p,t) AND (tau,d) REACTIONS. Kuhfeld, A. W.; Hintz, N. M. (Minnesota Univ., Minneapolis (USA). John H. Williams Lab. of Nuclear Physics). Nucl. Phys., A; 247: No. 1, 152-186(28 Jul 1975).

The $^{107}$Ag residual nucleus was studied in the core-excitation model by using the (p,t) and (tau,d) reactions. The L, J, pi of levels between 0.0 and 2.25 MeV were deduced from the combined reactions. The octupole state observed at 2.19 MeV in other experiments was resolved in (p,t) into a triplet of states at 2.182, 2.203 and 2.229 MeV; octupole strength was observed in (p,t) over a range from 1.144 to 2.229 MeV. Core excitation wave functions for the quadrupole $2^+$ and $2^{\prime+}$ vibration doublets of $^{107}$Ag were constructed by using electromagnetic data. These wave functions, combined with data from the $^{108}$Pd(p,t) core reaction, effectively reproduced the $^{109}$Ag(p,t) differential cross sections to these states. The ground-state L equals 0 transfer in (p,t) to $^{107}$Ag was only 0.752 +- 0.113 as strong as the corresponding transfer to $^{106}$Pd. This is an unexpectedly large blocking effect for an unpaired proton to exert upon a neutron-transfer reaction. An apparent dependence of the (p,t) angular distributions to states of $^{107}$Ag built upon the same core excitation was observed, depending upon the J of the final state. (auth)

**29799** PRE-EQUILIBRIUM PROTON EMISSION IN THE (n,p) REACTION ON INDIUM AT 14 MeV. Niidome, J.; Hyakutake, M.; Koori, N.; Kumabe, I.; Matoba, M. (Kyushu Univ., Fukuoka (Japan)). Nucl. Phys., A; 245: No. 3, 509-514(7 Jul 1975).

The (n,p) reaction on indium has been studied at a bombarding energy of 14.1 MeV by using a semiconductor-detector telescope. The emitted-proton spectrum was measured and compared with the predictions of the pre-equilibrium model and the statistical evaporation model. The prediction of the pre-equilibrium model developed by Braga-Marcazzan et al. reproduced well the emitted proton spectrum and the cross sections. (auth)

**29800** SPIN-PARITY, LIFETIME AND MAGNETIC MOMENT OF A SHORT-LIVED ISOMERIC STATE IN $^{118}$Sb. Plostinaru, D.; Ivanov, E. A.; Pascovici, G.; Iordachescu, A. (Institutul de Fizica Atomica, Bucharest (Romania)). Phys. Lett., B; 57: No. 3, 235-237(7 Jul 1975).

A $3^+$ isomeric state has been identified in $^{118}$Sb by pulsed-beam time-differential $\gamma$-ray measurements following the $^{118}$Sn(p,n) and $^{115}$In($\alpha$,n) reactions. The results of these measurements are $T_{\frac{1}{2}} = 20.6 \pm 0.6\ \mu s$, $E_\gamma = 54.4 \pm 0.5$ keV, $\alpha_K = 8.3 \pm 1.0$ and $\mu = +2.61 \pm 0.05$ n.m. (auth)

**29801** PERTURBED ANGULAR DISTRIBUTIONS IN THE PRESENCE OF ISOTROPIC PARAMAGNETIC RELAXATION.

Analytical Solution for Arbitrary Nuclear Spin and Electronic Spin $S = \frac{1}{2}$. Bosse, J.; Gabriel, H.; Vollmann, W. (Freie Univ. Berlin (F. R. Germany). Inst. fuer Atom- und Festkoerperphysik). Hyperfine Interactions; 1: No. 1, 33-39(Jun 1975).

The effect of paramagnetic relaxation on perturbed angular distributions is treated for nuclei interacting with their electronic shells via isotropic hyperfine interaction. The conditions are given under which Blume's analytical stochastic-model result for the nuclear perturbation factors $G_k(t)$ can be derived quantum mechanically. Systems with arbitrary nuclear spin, but electronic spin $S = \frac{1}{2}$, may be calculated without resorting to the assumption necessary for $S > \frac{1}{2}$. Explicit closed expressions for $G_k(t)$ can be found for this particular case. (auth)

**29802** ROTATIONAL DESCRIPTION OF SOME ODD-A NUCLEI IN THE MASS-100 REGION. Rekstad, J. (Niels Bohr Institutet, Copenhagen (Denmark)). Nucl. Phys., A; 247: No. 1, 7-20(28 Jul 1975).

The known spins, energies and spectroscopic strengths in transfer reactions and the $\gamma$-decay rates of states in the nucleus $^{103}$Ru are shown to agree closely with the predictions of the Nilsson model with Coriolis coupling. Comparisons with the level schemes of the nuclei $^{105}$Ru, $^{107}$Pd and $^{109}$Pd show that the structure of these nuclei also can be explained as rotational. The model employed is outlined, and it is shown that a correct treatment of the recoil effect is of particular importance in the description of weakly deformed nuclei. (auth)

**29803** LEVEL SCHEME OF $^{135}$Pr: PROLATE DEFORMATION OF THE $11/2^-$ ISOMER. Wisshak, K.; Klewe-Nebenius, H.; Habs, D.; Faust, H. (Heidelberg Univ. (F. R. Germany). 1. Physikalisches Inst.); Nowicki, G.; Rebel, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Kernphysik). Nucl. Phys., A; 247: No. 1, 59-73(28 Jul 1975).

The level scheme of $^{135}$Pr has been investigated by means of off-beam $\gamma$-ray and conversion electron measurements as well as by methods of in-beam $\gamma$ spectroscopy. $\gamma$-ray and conversion electron singles spectra, off-beam and in-beam $\gamma\gamma$ coincidences and $\gamma$ angular distributions were measured. From the experimental data a detailed scheme of 22 excited levels for $^{135}$Pr has been constructed. In addition to members of the decoupled band based on the $11/2^-$ state, six further negative-parity states were identified. These states are strongly populated in the $\beta$-decay of a $5/2$ isomer in the parent nucleus $^{135}$Nd. A comparison of all the negative-parity states with predictions of the alignment coupling model showed a nearly quantitative agreement, if softness of the core is taken into account. In this case, a prolate deformation with a deformation parameter $\beta \sim 0.13$ was obtained for the $11/2^-$ isomer in $^{135}$Pr. (auth)

**29804** STUDY OF THE $^{144}$Sm(d,p) REACTION AT 19 MeV. Booth, W.; Wilson, S. (Bradford Univ. (UK)). Nucl. Phys., A; 247: No. 1, 126-138(28 Jul 1975).

The $^{144}$Sm(d,p) reaction has been studied at an incident deuteron energy of 19 MeV by using the injector-tandem accelerator and the multichannel magnetic spectrograph of the University of Oxford. Angular distributions have been measured for transitions to levels of $^{145}$Sm up to an excitation energy of 3.2 MeV. Theoretical (d,p) distributions have been calculated using the program DWUCK, and orbital angular momentum transfers and spectroscopic factors have been deduced by comparing these calculations with the experimental data. The spectroscopic information derived from this study is more extensive than that previously reported, and many new assignments have been made. The level scheme of $^{145}$Sm has been found to resemble closely the level schemes of the other N = 83 nuclei. (auth)

**29805** SURFACE ABSORPTION OPTICAL MODEL POTENTIAL FOR 20 MeV TRITONS. Nurzynski, J. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Nucl. Phys., A; 246: No. 2, 333-356(21 Jul 1975).

Elastic (t,t) scattering at 20 MeV and from target nuclei with $A \geq 40$ has been analysed using four- or six-parameter optical model potentials with surface absorption. About ten parameter families were studied. Formulae for the mass dependence have been derived. Limitations of the conventional optical model are noticed and examined. It is shown first that the appearance of continuous or discrete ambiguities depends on the number of parameters used in the model and, secondly, that the linear dependence of potential depths on the symmetry parameter $(N - Z)/A$ cannot be associated in a simple way with the isospin interaction. It is suggested that these limitations are imposed by the mathematical form accepted generally for the potential components. (auth)

**29806** LEVEL STRUCTURE OF $^{147}$Nd. The $^{146}$Nd(n,$\gamma$) Reaction. Roussille, R.; Pinston, J. A.; Boerner, H.; Koch, H. R.; Heck, D. (Institut Max von Laue – Paul Langevin, 38 – Grenoble (France)). Nucl. Phys., A; 246: No. 2, 380-394(21 Jul 1975).

The level structure of $^{147}$Nd has been established from the study of the prompt $\gamma$-rays following thermal neutron capture in $^{146}$Nd. Within the energy range $50 < E_\gamma < 900$ keV the $\gamma$-radiation has been analyzed with three bent-crystal spectrometers installed at the Grenoble high-flux reactor. Measurements with Ge(Li) detectors operated in Compton suppression and pair mode covered the energy range $0.1 < E_\gamma < 5.3$ MeV. Gamma–gamma coincidences and an additional low-energy spectrum have been taken with different Ge(Li) detectors at the Karlsruhe research reactor FR2. Using all these data, a level scheme is proposed for $^{147}$Nd comprising 22 excited states up to 2 MeV. It is shown that the present level energies differ from those previously found in the $^{146}$Nd(d,p) reaction by a systematic shift of 50 keV, which has led to a different interpretation of the ground state. For most levels spin and parity values are proposed. (auth)

**29807** LEVEL STRUCTURE OF $^{147}$Nd. II. The Decay of $^{147}$Pr. Pinston, J. A.; Rousille, R.; Bailleul, G.; Blachot, J.; Bocquet, J. P.; Monnand, E.; Pfeiffer, B.; Schrader, H.; Schussler, F. (Institut Max von Laue – Paul Langevin, 38 – Grenoble (France)). Nucl. Phys., A; 246: No. 2, 395-401(21 Jul 1975).

The decay of $^{147}$Pr → $^{147}$Nd ($T_{\frac{1}{2}}$ = 12 min) has been studied using the unslowed fission product separator LOHENGRIN (installed at the Grenoble high-flux reactor) to produce the $^{147}$Pr nucleus. A decay scheme for $^{147}$Pr, including 11 levels, has been established. The $\beta$-branching and log ft values for all the excited levels were deduced from a detailed analysis of $\gamma$-intensity balances. Furthermore, the spins and parities for most of the excited states observed were obtained from the comparison between the present work and the neutron capture results. (auth)

**29808** BETA-DECAY PROPERTIES OF STRONGLY NEUTRON-RICH NUCLEI. Aleklett, K.; Nyman, G. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Institutionen foer Fysik); Rudstam, G. (Forskningsraadens Lab., Studsvik (Sweden)). Nucl. Phys., A; 246: No. 2, 425-444(21 Jul 1975).

Experimental $\beta$-strength functions for about 50 neutron-rich mass-separated fission products with half-lives between 0.8 s and 30 s have been obtained at the OSIRIS facility. The $\beta$-strength to excited states depopulating by delayed-neutron emission is evaluated separately. The $\beta^-$ strength functions are found to increase strongly with excitation energy, which is in contrast to the approximately energy-independent $\beta$-strength found for EC decay. By using semiempirical values for the level density, the average transition rate per energy level was evaluated under the assumption that only allowed transitions contribute to the decay. This alternative way of analyzing the data gives a more uniform picture of the $\beta$-decay to highly excited states since the transition rates are found to be roughly independent of excitation energy (above the pairing energy). A model of constant transition rate to each final level is introduced and its systematic behavior is studied. Its use for estimating half-lives of unmeasured nuclides is of value for calculations on nucleosynthesis by the "r-process". (A listing of $\beta$-feed and $\beta$-strength functions is available on request.) (auth)

**29809** CROSS SECTIONS FOR THE (n,n'), (n,p) AND (n,2n) REACTIONS ON $^{107}$Ag AND $^{109}$Ag ISOTOPES. Augustyniak, W.; Herman, M.; Marcinkowski, A. (Institute of Nuclear Research, Warsaw (Poland)). Nucl. Phys., A; 247: No. 2, 231-237(4 Aug 1975).

The cross sections for (n,n'), (n,p) and (n,2n) reactions on the target nuclei $^{107}$Ag and $^{109}$Ag were measured by the activation technique in the neutron energy range 13 to 18 MeV. The results are interpreted in terms of the compound nucleus and precompound emission models. (auth)

**29810** HALF-LIVES OF THE FIRST EXCITED $6^+$ AND $7^-$ STATES IN $^{126}$Te AND $^{128}$Te. Soares, J. C.; Herzog, P.; Huebel, H.; Kluge, A.; Thomas, W. (Bonn Univ. (F. R. Germany). Inst. fuer Strahlen- und Kernphysik). Nucl. Phys., A; 247: No. 2, 274-282(4 Aug 1975).

The lifetimes of the lowest excited $6^+$ and $7^-$ states in $^{126}$Te and $^{128}$Te were measured by the delayed coincidence technique with the following results: $^{126}$Te: $T_{\frac{1}{2}}(6^+) = 69 \pm 2$ psec and $T_{\frac{1}{2}}(7^-) = 0.15 \pm 0.02$ nsec; $^{128}$Te: $T_{\frac{1}{2}}(6^+) = 0.48 \pm 0.03$ nsec and $T_{\frac{1}{2}}(7^-) = 2.404 \pm 0.024$ nsec. The reduced transition probabilities for the $(6^+ \rightarrow 4^+)$, $(7^- \rightarrow 6^+)$ and $(7^- \rightarrow 5^-)$ transitions are derived and compared with theoretical estimates. (auth)

**29811** $P_n$ VALUES OF THE $^{235}$U($n_{th}$,f) PRODUCED PRECURSORS IN THE MASS CHAINS 90, 91, 93-95, 99, 134, AND 137-139. Asghar, M.; Gautheron, J. P.; Bailleul, G.; Greif, J.; Schrader, H.; Siegert, G. (Institut Max von Laue – Paul Langevin, 38 – Grenoble (France)); Bocquet, J. P.; Ristori, C.; Crancon, J.

(CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale); Crawford, G. I. (Glasgow Univ. (UK). Kelvin Lab.). Nucl. Phys., A; 247: No. 2, 359-376(4 Aug 1975).

The first results are reported on the $P_n$ values obtained with the recoil focussing parabola-type mass separator for unslowed fission products Lohengrin installed at the Grenoble high flux reactor. The mass chains studied were 90, 91, 93, 94, 95, 99, 134, 137, 138 and 139. Both the neutron and the $\beta$ activities were measured simultaneously. The technique used to measure the neutron and the $\beta$ activities and the method of analyzing the experimental data are discussed in detail. The present work led to (i) three new periods corresponding to the new isotopes of selenium ($^{91}$Se, $T_{\frac{1}{2}} = 0.27 \pm 0.05$ sec), strontium ($^{95}$Sr, $0.6 \pm 0.2$ sec) and tellurium ($^{138}$Te, $1.3 \pm 0.3$ sec); (ii) accurate periods of $^{99}$Y($T_{\frac{1}{2}} = 1.45 \pm 0.22$ sec) and $^{134}$Sn ($0.7 \pm 0.2$ sec); (iii) four new delayed neutron precursors consisting of $^{91}$Se, $^{94}$Kr, $^{99}$Sr and $^{138}$Te; (iv) six new $P_n$ values corresponding to the precursors $^{91}$Se ($P_n = 21 \pm 10\%$), $^{94}$Kr ($5.7 \pm 2.2\%$), $^{99}$Sr ($3.4 \pm 2.4\%$), $^{99}$Y ($1.2 \pm 0.8\%$), $^{134}$Sn ($17 \pm 13\%$) and $^{138}$Te ($6.3 \pm 2.1\%$); (v) a precise $P_n$ value of the precursor $^{137}$Te ($2.5 \pm 0.5\%$); (vi) a redetermination of the $P_n$ values of the precursors $^{90,91}$Br, $^{93}$Kr, $^{93,94,95}$Rb and $^{137,138,139}$I. The results of this work are discussed and compared with the existing data. The low-level sensitivity of the present detection system is determined to be $P_n(m)\, Y_q(m) \gtrsim 0.4 \times 10^{-6}$ n/f (where $Y_q$ (m) is the cumulative yield for the mass m and the ionic charge q). (auth)

**29812** INELASTIC SCATTERING OF ELECTRONS FROM $^{90}$Zr. Singhal, R. P.; Brain, S. W.; Curran, C. S.; Gillespie, W. A.; Johnston, A.; Lees, E. W.; Slight, A. G. (Univ. of Glasgow). J. Phys., G (London); 1: No. 5, 558-578(20 Jun 1975).

The states of $^{90}$Zr up to 5.8 MeV excitation energy have been studied by (e,e') in the momentum transfer range from 0.29 to 1.07 fm$^{-1}$. Ground state transition probabilities and transition radii were obtained for the levels excited. Previously published electron scattering data on $^{90}$Zr are included in the extraction of these parameters. A comparison of results is made with the model independent measurements of the ($\gamma$,$\gamma$') reaction for the $2^+$ states. Wherever possible, the results for the electromagnetic transition rates are compared with the iso-scalar transition rates and those obtained from (p,p') reactions. Theoretical calculations are seen to be inadequate to describe the strength of the transitions observed in the present experiment. (auth)

**29813** GAMMA SPECTRUM AND DECAY SCHEME OF $^{115}$Sb. Kiselev, B. G. (Inst. of Nuclear Physics, Tashkent). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 168-170(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2654-2656 (1974).

The nuclide $^{115}$Sb was produced as a result of the (p,2n) reaction on a 95% enriched $^{116}$Sn foil. The proposed decay scheme for $^{115}$Sb is shown and differences from previously proposed schemes are discussed. (1 figure, 1 table) (SDF)

**29814** SPINS AND PARITIES OF $^{149}$Gd LEVELS. Budzynski, M.; Ion-Mikhai, R.; Morozov, V. A.; Muminov, T. M.; Subotovich, M.; Fuya, H.; Kholbaev, I. (Samarkand State Univ., USSR). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 25-29(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2493-2498 (1974).

Gamma-gamma angular correlations were investigated for a number of cascades following $^{149}$Tb decay; specifically, the 652-165, 862-165, 187-165, 388-652, 388-817, and 853-352 keV cascades and the 388-652-165 keV triple cascades going parallel to the 388-464-187-165 keV quadrupole cascade were examined. As a result of the analysis, the spins of the 352, 817, 1026, and 1205 keV levels of $^{149}$Gd were established as 3/2, 5/2, 3/2, and 3/2, respectively. (6 fig., 2 tables) (auth)

**29815** MIXING OF VIBRATIONAL AND TWO-QUASIPARTICLE EXCITATIONS IN Te, Sn, AND Cd. Vdovin, A. I.; Stoyanov, C. H. (Joint Inst. for Nuclear Studies, Moscow). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 124-129(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2604-2609 (1974).

The interaction between two-quasiparticle and vibrational excitations and their effect on the properties of $2^+$ and $3^-$ states in Te, Sn, and Cd is investigated. Energies of states, quadrupole moments and electric transition probabilities are calculated. (3 tables) (SDF)

**29816** EXCITATION FUNCTIONS FOR $^{116}$Cd + d REACTIONS. Padalko, V. Yu.; Zarubin, P. P.; Sergienko, V. A. (Leningrad State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 101-103(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2578-2580 (1974).

An investigation has been carried out of the excitation functions for the $^{116}$Cd(dp)$^{117*,g}$Cd and $^{116}$Cd(d,2n)$^{116}$In reactions. The former exhibits an excitation-function minimum at deuteron energy of about 9.6 MeV, the appearance of which is due to the strong charge exchange coupling between the (dp) and (dn) reaction channels. (4 figures) (auth)

**29817** DECAY OF 2.4 H $^{117}$Cd GROUND AND 3.4 H $^{117}$Cd ISOMERIC STATE. Tang, C. W.; Pakkanen, A.; Mester, Z. C.; Coryell, C. D. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry); Chilosi, G. (Naples Univ. (Italy). Scuola di Perfezionamento in Fisica Teorica e Nucleare); Bos, K.; Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). Z. Phys., A; 272: No. 3, 301-310(Mar 1975).

5 figs.; 4 tabs.; 26 refs.

The decay was investigated with the use of high-resolution Si(Li) and Ge(Li) detectors, also in an anti-Compton arrangement. Spectra from the two isomers were resolved by comparing young reactor-produced $^{117}$Cd with aged cyclotron-produced $^{117}$Cd. Ge(Li)–Ge(Li) coincidences were measured with a multi-parameter analyzer. A hundred observed $\gamma$-rays are placed in a level scheme of $^{117}$In. Possible theoretical interpretations are discussed. The I. T. branching of $^{117}$In is $(47.1 \pm 1.5)\%$. Only about 1% of $^{11}/_{2}^{-}$ isomeric $^{117}$Cd decays to 1.93 h $^{1}/_{2}^{-}$ isomeric $^{117}$In and 10.9% of $^{1}/_{2}^{+}$ $^{117}$Cd ground state decays to the $^{9}/_{2}^{+}$ $^{117}$In ground state bypassing the isomeric In state. (auth)

**29818** K-CAPTURE PROBABILITY IN THE DECAY OF $^{139}$Ce(137.5d). Dasmahapatra, B. K. (Saha Inst. of Nuclear Physics, Calcutta). Pramana; 4: No. 5, 218-221(May 1975).

The K-capture probability ($P_K$) in the decay of $^{139}$Ce(137.5d) has been determined from the analysis of the K x-ray gamma ray sum-peak observed with a Ge(Li) x-ray detector. Furthermore, $P_K$ is estimated independently from the measurement of the K x-ray intensity in the decay, using the known conversion coefficients of the 165.8 keV transition. Using the weighted average of $P_K$ measured as above, the mass difference between $^{139}$Ce and $^{139}$La is found to be 273 +21-13 keV. (2 figures, 1 table) (auth)

**29819** DECAY OF $^{105}$Tc TO LEVELS IN $^{105}$Ru. Suemmerer, K.; Kaffrell, N.; Trautmann, N. (Mainz Univ. (F. R. Germany). Inst. fuer Anorganische Chemie und Kernchemie). Z. Phys., A; 273: No. 1, 77-84(May 1975).

3 figs.; 2 tabs.; 27 refs.

The $\beta^-$-decay of 7.6-min $^{105}$Tc was investigated by $\beta$- and $\gamma$-ray singles and coincidence measurements. The activities were produced by thermal-neutron-induced fission of $^{235}$U or $^{239}$Pu and subsequent chemical separation of the technetium fraction from the fission product mixture. A Q-value of 3.2 MeV was determined. In a delayed coincidence experiment the lifetime of the first excited state in $^{105}$Ru at 20.55 keV was measured to be 340 nsec. A level scheme of $^{105}$Ru is proposed and compared with the results of recent nuclear reaction studies like $^{104}$Ru(d,p) and $^{104}$Ru(n,$\gamma$). From beta branching ratios to levels in $^{105}$Ru, ground state spin and parity of $^{5}/_{2}^{+}$ can be suggested for $^{105}$Tc in accordance with the trend observed in neutron rich technetium isotopes. (GE)

**29820** MEASUREMENT OF $^{90}$Zr($\gamma$,2n)$^{88}$Zr AND $^{90}$Zr($\gamma$,np) $^{88}$Y CROSS SECTIONS. Brajnik, D.; Jamnik, D.; Kernel, G.; Korun, M.; Miklavzic, U.; Pucelj, B.; Stanovnik, A. (Joseph Stefan Inst., Ljubljana, Yugoslavia). Fizika (Zagreb); 6: No. 4, 255-256(Dec 1974).

The Zr target was irradiated with betatron bremsstrahlung of different end-point energies. A 27 cm$^3$ Ge(Li) detector was used to measure the activity of the 0.394 MeV $^{88}$Y* state and the activity of the 1.836 MeV $^{88}$Sr state. The cross sections for the reactions ($\gamma$,2n) and ($\gamma$,np) were determined by the method of Penfold and Leiss. As seen from the decay scheme of the giant resonance the decay of the T > part of the giant resonance through the ($\gamma$,2n) channel is isospin forbidden. (auth)

**29821** REACTION $^{106}$Cd($^3$He,$\alpha$)$^{105}$Cd. Chapman, R.; Dracoulis, G. D. (Univ. of Manchester, Eng.). J. Phys., G (London); 1: No. 6, 657-664(1 Aug 1975).

The Harwell multi-angle magnetic spectrograph and tandem Van de Graaff electrostatic generator have been used to study the states of $^{105}$Cd populated in the single neutron pickup reaction $^{106}$Cd($^3$He,$\alpha$)$^{105}$Cd at an incident $^3$He energy of 18.0 MeV. Eleven states of the final nucleus were identified up to an excitation

energy of 3 MeV. Orbital angular momentum $l_n$ values of the transferred neutron and single neutron spectroscopic factors of the states excited were extracted by comparison of the measured $\alpha$-particle angular distributions with predictions based on the distorted wave Born approximation. The results are compared with the predictions from pairing theory. (auth)

**29822** COMPARISON OF ISOBARIC ANALOG RESONANCE EXPERIMENTS WITH UNIFIED MODEL CALCULATIONS FOR N = 83 NUCLEI. Clement, H.; Graw, G. (Erlangen-Nuernberg Univ., Erlangen (F. R. Germany)). Phys. Lett., B; 57: No. 4, 323-326(21 Jul 1975).

The $0_1^+$ and $2_1^+$ parentage expansion of excited states in $^{139}$Ba, $^{141}$Ce and $^{145}$Sm has been determined via the analysis of the elastic and inelastic scattering of polarized protons in the energy region of their analog resonances. The extracted spectroscopic information indicates that present unified model calculations give a considerable overestimate of the strength of characteristic configurations in the weak coupling structure. (auth)

**29823** PHOTOREACTIONS IN GAS-STREAM. Farman, M.; Loose, R.; Rechenberg, H.v.; Schneider, H. (Giessen Univ. (F. R. Germany). Abt. Grossgeraete (Angewandte Kernphysik)); Sattler, E. L.; Trampisch, W. (Giessen Univ. (F. R. Germany)). Nucl. Instrum. Methods; 127: No. 1, 151-154(15 Jul 1975). (In German).

A gas-stream apparatus for nuclear photoreactions is described and jet-activity measurements with neon and argon gases discussed. (auth)

**29824** EXCITATION OF INNER HOLE STATES IN HEAVY NUCLEI WITH THE $(\tau,\alpha)$ REACTION AT 205 MeV. Gerlic, E.; Langevin-Joliot, H.; Van de Wiele, J.; Duhamel, G. (Paris-11 Univ., 91- Orsay (France). Inst. de Physique Nucleaire); Kaeline, J. (Uppsala Univ. (Sweden). Gustaf Werner Institutet). Phys. Lett., B; 57: No. 4, 338-340(21 Jul 1975).

Energy spectra were measured for the $(\tau,\alpha)$ reaction at 205 MeV on $^{90}$Zr, $^{118,124}$Sn and $^{208}$Pb. Results on the valence neutron shells and on the inner $1f_{\frac{5}{2}}$ shell in $^{90}$Zr, $1g_{\frac{9}{2}}$ subshell in $^{118,124}$Sn ($T_<$ and $T_>$ components) and $1h_{\frac{9}{2}}$ subshell in $^{208}$Pb are presented. (auth)

## Nuclear Properties and Reactions, 150 ≤ A ≤ 189

*Refer also to abstracts 29689, 29758, 29789, 29795, 29835, and 29909.*

**29825** (COO-2176-28) CAPTURE CROSS SECTION AND RESONANCE PARAMETERS OF THULIUM-169. Arbo, J. C.; Felvinci, J. P.; Mekkonian, E.; Havens, W. W. Jr. (Columbia Univ., New York (USA)). 1975. 5p. (CONF-751019-2). Dep. NTIS $4.00.

From ANS winter meeting; Washington, District of Columbia, USA (27 Oct 1975).

The previously analyzed energy range for thulium capture resonance parameters is extended from 1 keV to 2 keV. In addition, point and group averaged thulium cross section curves are extended to above 2 keV and $^{181}$Ta impurity levels are discussed. (SDF)

**29826** (JINR-E6-8886) LEVELS IN $^{163}$Tm EXCITED BY THE DECAY OF 11.4 MIN $^{163}$Yb. Adam, I.; Gromov, K. Ya.; Honusek, M.; Islamov, T. A.; Khamidov, A. Sh.; Kuznetsov, V. V.; Ortlepp, H. G.; Siebert, H. U.; Strusny, H. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 28p. Dep. NTIS (US Sales Only) $4.50.

The decay of $^{163}$Yb (11.4 min) has been investigated with Ge(Li), Si(Li) and NaI(Tl) detectors, a toroidal beta-spectrometer and magnetic beta-spectrographs by using isobarically separated samples produced by the YASNAPP facility at Dubna. The single $\gamma$-ray spectrum, the conversion electron spectrum, prompt and delayed $\gamma$-$\gamma$ coincidences and $\beta^+$-$\gamma$ coincidences have been measured. 110 new $\gamma$-ray transitions have been observed. A decay scheme of $^{163}$Yb is proposed involving 30 excited states in $^{163}$Tm. The first members of the rotational bands $\frac{1}{2}^+$ [411], $\frac{7}{2}^-$[404], $\frac{1}{2}^-$[541], $\frac{3}{2}^+$[411] and $\frac{7}{2}^-$[523] have been identified. Possibilities of interpretation of the high-lying levels are discussed. The Q-value of $^{163}$Yb has been determined to be 3370 ± 100 keV. (8 figures, 4 tables) (auth)

**29827** (JINR-R-6-8229) IDENTIFICATION OF $^{160}$Yb. Bajer, G.; Shtrusnyi, Kh.; Gonusek, M.; Yakhim, M.; Zibert, Kh. U.; Zuber, K.; Potempa, A. V.; Lyatushinskii, A.; Zuber, Ya.; Penev, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 9p. (In Russian). INIS.

The existence of the isotope $^{160}$Yb with a half-life of $T_{\frac{1}{2}} = 4.8 \pm 0.2$ min was established. The energy and intensity of the gamma radiation emitted in its decay were measured and found to be: 132.23 keV (9.9), 140.35 keV (16.6), 173.76 keV (77.4), 215.78 keV (32.0), and 372.2 keV (3.5). (tr-auth)

**29828** SHAPE ISOMERISM IN MERCURY ISOTOPES. Kolb, D.; Wong, C. Y. (Oak Ridge National Lab., Tenn. (USA)). Nucl. Phys., A; 245: No. 2, 205-220(30 Jun 1975).

The energies of the mercury isotopes in their oblate, prolate, and bubble shapes are studied within the framework of the single-particle K-matrix theory. A change from an oblate ground state to a prolate ground state is observed when the mass is decreased from 184 to 182. Self-consistent stable bubble configurations were also obtained for these isotopes. They lie a few MeV from the ground deformed state, coming down lower for the mass region around A approximately 200 and 182. For the isotopes of $^{188}$Hg, $^{186}$Hg, and $^{182}$Hg, the oblate and prolate minima are nearly degenerate; a strong mixing of the prolate and oblate configuration is expected. This mixing is occasionally enhanced for states with non-zero angular momentum when their energies become accidentally near-degenerate due to their differences in moments of inertia. Such hybridization of shapes is studied in terms of a phenomenological two-center collective model. Good qualitative agreement with experimental energy spectra and branching is observed, indicating a decrease of the prolate-oblate energy difference as the mass number decreases from 188 to 184. (auth)

**29829** HIGH-SPIN STATES IN $^{187,189}$Ir. Coexistence of Strong-coupling, Rotation-alignment, and Weak-coupling. Kemnitz, P.; Funke, L.; Sodan, H.; Will, E.; Winter, G. (Zentralinsittut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Nucl. Phys., A.; 245: No. 2, 221-242 (30 Jun 1975).

The level schemes of the odd-proton nuclei $^{187}$Ir and $^{189}$Ir have been studied using in-beam spectroscopic methods. Energies, intensities, angular distributions and coincidences of the $\gamma$-rays following the $^{185,187}$Re($\alpha$, 2n)$^{187,189}$Ir reactions were determined at an $\alpha$-particle energy of 27 MeV. Furthermore, conversion electrons and delayed singles and coincidence $\gamma$-ray spectra were recorded. From the $^{187}$Re($\alpha$, 4n)$^{187}$Ir reaction ($E_\alpha$ = 48 MeV) singles $\gamma$-ray spectra at different angles of emission and $\gamma$-$\gamma$ coincidences were measured. A singles $\gamma$-ray spectrum was also taken from the $^{189}$Os(p, n)$^{189}$Ir reaction. About 45 new levels were found in each nucleus. Two positive parity bands are ascribed to the Nilsson configurations $\frac{3}{2}^+$[402] and $\frac{1}{2}^+$[400]. As much as 20 levels in $^{187}$Ir are related to excitations of the $h_{\frac{9}{2}}$ configuration. Most of them form the characteristic sequences predicted by the rotation-aligned coupling scheme. The levels connected with the $\frac{11}{2}^-$ isomer form separated multiplets rather than rotational bands. They are described as being an $h_{\frac{11}{2}}$ excitation weakly coupled to a Pt core. In $^{189}$Ir a 3.8 ms isomer found at 2332.3 MeV was assigned as $I^\pi = \frac{25}{2}^+$. (auth)

**29830** NUCLEAR STRUCTURE STUDY OF $^{165}$Ho USING THE (t, $\alpha$), ($\alpha$, t) AND ($^3$He, d) REACTIONS. Wagner, L. K.; Kleinheinz, P.; Sheline, R. K. (Florida State Univ., Tallahassee (USA)); Burke, D. G.; Cheung, H. C. (McMaster Univ., Hamilton, Ontario (Canada)). Nucl. Phys., A.; 246: No. 1, 43-60(14 Jul 1975).

The level structure of $^{165}$Ho has been studied by means of the $^{166}$Er(t, $\alpha$) $^{165}$Ho, $^{164}$Dy($\alpha$, t)$^{165}$Ho, and $^{164}$Dy($^3$He, d)$^{165}$Ho reactions using magnetic spectrographs and photographic emulsions. The results were interpreted on the basis of the Nilsson model with pairing and Coriolis mixing effects included. Experimental nuclear structure factors were obtained and compared with calculated results. Previously identified bands based on the $\frac{7}{2}$[523], $\frac{3}{2}$[411], $\frac{1}{2}$[411], $\frac{7}{2}$[404], and $\frac{5}{2}$[413] Nilsson orbitals were observed. The previously suggested $\frac{1}{2}$[541] band was confirmed and levels up to spin $\frac{9}{2}$ were assigned. The $\frac{11}{2}$ member of the $\frac{5}{2}$[514] band was also identified. States assigned earlier as the spin $\frac{5}{2}$ and $\frac{7}{2}$ members of the $\frac{5}{2}$[532] band were reassigned to the $\frac{5}{2}$[402] orbital. New evidence is presented which indicates that the previously assigned $\frac{5}{2}$[413] band is actually the (Ko + 2) $\gamma$-vibration based on the $\frac{1}{2}$[411] state, with a large admixture (~ 50%) of the $\frac{5}{2}$[413] single-particle configuration. (auth)

**29831** THEORETICAL INVESTIGATIONS OF ROTATIONAL BANDS IN ODD-MASS NUCLEI. Ring, P.; Mang, H. J. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.); Banerjee, B. (Tata Inst. of Fundamental Research, Bombay (India)). Nucl. Phys., A.; 225: No. 1, 141-156(4 Jun 1974).

Rotational bands in $^{159}$Dy and $^{155}$Dy are studied within the framework of the selfconsistent cranking theory. Good agreement between calculated and experimental level schemes is obtained. In particular, no attenuation factor for Coriolis matrix

elements is needed for the strongly distorted bands of even parity. (auth)

**29832** THE EFFECTIVE CROSS SECTION OF THE $^{165}$Ho($\gamma$, xn) REACTION. Catana, D.; Baciu, G.; Ionescu-Bujor, M.; Niculescu, V. I. R.; Iliescu, C. (Institutul de Fizica Atomica, Bucharest (Rumania)). Nucl. Phys., A.; 225: No. 1, 157-170(4 Jun 1974).

The $^{165}$Ho($\gamma$, xn) reaction cross section has been measured with a 100 keV bin in the range from threshold up to 23 MeV. The analysis of the yield curve is based on the least structure solution using the thick-target forward-direction bremsstrahlung spectrum. Finally, taking into account the Nilsson level scheme, the total El photoabsorption cross section was computed and compared with the present data and other published experimental data. (auth)

**29833** BAND MIXING IN $^{184}$W, $^{186}$Os, AND $^{188}$Os, AND THE NUCLEAR STRUCTURE OF $^{184}$W. Svoren, M. D. Baton Rouge; Louisiana State University (1974). 198p. University Microfilms Order No. 75-14,289.

Thesis (Ph. D.).

The level structure of $^{184}$W, $^{186}$Os, and $^{188}$Os has been investigated through the radioactive decay of the rhenium isotopes $^{184}$Re, $^{186}$Re, and $^{188}$Re. The primary objective of this study was to determine the applicability of the perturbative band-mixing model to these transitional nuclei. To this end, high resolution Ge(Li) and Si(Li) detectors, used in conjunction with a 4096 channel analyzer interfaced to a minicomputer, have been used to accurately measure gamma-ray and conversion electron energies and intensities accompanying the decay of the rhenium isotopes. The non-linearity of the gamma-ray spectrometer system was calibrated to optimize the accuracy of energy measurements. This enabled energy determinations of the prominent gamma rays to within 40 eV when measured relative to a set of precise energy standards. A Ge(Li) detector with a calibrated absolute photopeak efficiency curve was used to measure gamma-ray intensities. The Si(Li) detector was used to obtain conversion electron intensities. (Diss. Abstr. Int., B)

**29834** IDENTIFICATION OF THE NEW ISOTOPES $^{189}$Tl AND COEXISTENCE OF SPHERICAL AND DEFORMED SHAPES IN THE LIGHT MASS MERCURY ISOTOPES. Bosworth, E. L. Jr. Nashville; Vanderbilt University (1974). 155p. University Microfilms Order No. 75-12,762.

Thesis (Ph. D.).

Levels in $^{189}$Hg populated from the decay of $^{189}$Tl have been studied for the first time. New even parity levels at 1508.9 keV, $6^+$; 1969.5 keV, $8^+$; 880.9 keV, $2^+$; 1207.7 keV, $4^+$, and 1776.5 keV, $6^+$ have been added to the decay scheme, and strong evidence has been generated for a $5^-$ level at 1908.9 keV. Levels have also been discovered at 2200.5 keV (tentatively $7^-$) and 2586 keV (probably either $9^-$ or $8^+$). Fairly good evidence has been generated for a $2^+$ level at 977 keV. These data provide evidence for a shift from spherical to deformed shapes for the states observed. In particular, two even parity bands, one associated with each shape, are observed with states both above and below the crossing of the two bands seen for the first time in the mercury isotopes. Based on our data, the nucleus $^{189}$Tl was determined to have at least two levels which decay directly to $^{189}$Hg--a higher spin isomer with half life 77.4 +- 5.8 seconds and a lower spin isomer with a half life of 62.4 +- 5.6 seconds. The higher spin state is thought to be $7^+$ and the lower spin state $3^+$ with a less likely choice of $2^-$. (Diss. Abstr. Int., B)

**29835** NUCLEAR STRUCTURE OF $^{159}$Tb VIA PROTON-TRANSFER REACTIONS. Splett, J. A. Ann Arbor, MI; Univ. of Michigan (1974). 91p. University Microfilms Order No. 75-10,301.

Thesis (Ph. D.).

Angular distributions were measured for the $^{158}$Gd(alpha,t)$^{159}$Tb and $^{158}$Gd($^3$He,d)$^{159}$Tb reactions from 0 to 35$^0$ and from 0 to 30$^0$, respectively, with bombarding energies of E/sub alpha/ equals 45.5 MeV and E/sub $^3$He/ equals 46.5 MeV. The triton and deuteron tracks were recorded in Ilford K2 photographic emulsions with Al absorbers of 125 and 40 mils, respectively. A standard DWBA one-step direct reaction analysis with corrections for pairing effects, Coriolis coupling, and particle-vibrational effects was performed. The previously known $1/2^+$[411], $5/2^+$[413], $5/2^-$[532] single-particle bands and the $1/2^+$[411]-vibrational bands at 580 and 970 keV were identified as well as the $1/2^-$[541], $7/2^-$[523], $5/2^+$[402], and $1/2^+$[404] bands. An l equals 1 transition at 1068 keV was extremely tentatively assigned as the $1/2^-$[530] bandhead. The $7/2$ member of the lower vibrational band and the $5/2$ member of the upper vibrational band were resolved and identified. The $7/2$ and $9/2$ members of the $5/2^+$[402] band were tentatively assigned at 1085 and 1195 keV, respectively. (auth)

**29836** SELECTED ASPECTS OF VERY HEAVY ION REACTIONS. Huizenga, J. R. (Univ. of Rochester, NY). Nukleonika; 20: No. 4, 291-344(1975).

The reactions of very heavy projectiles (A greater than or equal to 40) and heavy targets are discussed. Particular emphasis is given to a new type of direct reactions process which we call strongly damped collisions. This process is characterized by 1) nucleon transfer resulting in two fragments with masses in the general vicinity of the target and projectile 2) strong damping in the energy degrees of freedom and 3) angular distributions which are strongly peaked similar to a direct process. Both entrance and exit channel limitations on the stability of the compound nucleus are reviewed. Various types of heavy ion nuclear potentials are discussed in relation to the critical angular momentum in the entrance channel. (23 figures, 8 tables, 48 references) (auth)

**29837** EQUILIBRIUM DEFORMATIONS AND EXCITATION ENERGIES FOR NON-COLLECTIVE STATES IN ODD-Z RARE-EARTH NUCLEI. Nielsen, B. S.; Bunker, M. E. (Los Alamos Scientific Lab., N. Mex. (USA)). Nucl. Phys., A; 245: No. 3, 376-396(7 Jul 1975).

Nuclear potential energy surfaces have been calculated for one-quasiparticle states in the odd-Z rare-earth nuclei. The calculations are based on the Nilsson model with inclusion of nuclear pairing effects. A renormalization of the energy surface to that of a liquid drop is made using the Strutinsky method. The lowest minima in the potential energy surfaces yield deformations (epsilon$_2$, epsilon$_4$) and excitation energies of the one-quasiparticle states, which can be compared with the experimental values after appropriate corrections, including a contribution from zero-point rotational motion. Many of the empirical energy trends among the one-quasiparticle states are well reproduced by these calculations. Some of the observed trends are attributable to variation in the hexadecapole (epsilon$_4$) deformation. (auth)

**29838** MIXING OF THE TRANSITIONS FROM THE $3^+$ QUASI $\gamma$-BAND LEVEL IN $^{152}$Gd. Helppi, H.; Pakkanen, A.; Hattula, J. (Jyvaeskylae Univ. (Finland). Dept. of Physics). Nucl. Phys., A; 247: No. 2, 317-321(4 Aug 1975).

The directional correlation method was used to determine the multipole mixing ratios of some $\gamma$ transitions in $^{152}$Gd. The 678.6 and 1089.8 keV $\gamma$-rays from the $3^+$ quasi $\gamma$-band level were observed to be almost pure E2 transitions, which is in disagreement with earlier results. The B(E2) ratios of the transitions from this level are consistent with theoretical calculations. (auth)

**29839** NUCLEAR STRUCTURE AND THE HYPERFINE INTERACTION OF ORIENTED $^{152}$Eu, $^{155}$Eu, AND $^{153}$Gd IN GOLD. Barclay, J. A.; Perczuk, B. (Monash Univ., Clayton (Australia). Dept. of Physics). Hyperfine Interactions; 1: No. 1, 15-24(Jun 1975).

Nuclear orientation of $^{152,155}$Eu and $^{153}$Gd in gold has been used to determine the nuclear magnetic moment of $^{155}$Eu, ($\mu$ $^{155}$Eu) = 1.93 ± 0.26 n.m., and several mixing ratios of $\gamma$ and $\beta$ transitions in the decays. The hyperfine field of dilute EuAu alloys was found to be $H_{hf}$ = 134 ± 10 kOe and for GdAu, $|\mu H|$ was found to be in the range 0 to 1.0 × 10$^5$ Oe-n.m. (auth)

**29840** LEVELS OF $^{188}$Os POPULATED IN THE $^{189}$Os(d,t)$^{188}$Os REACTION AND IN THE DECAY OF 41h $^{188}$Ir. Thompson, R.; Ikeda, A.; Sheline, R. K. (Florida State Univ., Tallahassee (USA). Dept. of Physics); Cunnane, J. C.; Yates, S. W.; Daly, P. J. (Purdue Univ., Lafayette, Ind. (USA). Dept. of Chemistry). Nucl. Phys., A; 245: No. 3, 444-460(7 Jul 1975).

The level structure of $^{188}$Os has been investigated by the $^{189}$Os(d,t)$^{188}$Os reaction using a broad-range magnetic spectrograph, and the properties of the $^{188}$Os levels populated in the decay of $^{188}$Ir have been re-examined. The (d,t) results yield new information about the location of two-neutron excitations in $^{188}$Os involving the $3/2$[512] orbital. Since the $^{189}$Os ground state contains admixtures of both K = $3/2$ and K = $1/2$ character, cross section formulae for single-neutron transfer from a target state which is not pure in K are considered, and it is found that rather small K = $1/2$ admixtures in the $^{189}$Os ground state give rise to striking interference effects, which are manifested in the experimental (d,t) cross sections into the members of the $^{188}$Os ground state band. The consequences of the mixed character of the target state on the (d,t) population of members of the $K^\pi = 2^+$ $\gamma$-vibration and of higher-lying two-quasiparticle bands are also discussed. (auth)

**29841** MIXING OF VIBRATIONAL AND TWO-QUASIPARTICLE EXCITATIONS OF ISOTONES WITH N = 80, 82, AND 84. Vdovin, A. I.; Stoyanov, Ch. (Joint Inst. for Nuclear Studies, Moscow). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 119-123(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR(29 Jan 1974). Translated

from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2598-2603 (1974).

There has been interest recently in the interaction between vibrational and two-quasiparticle excitations in even-even nuclei. For the isotones with N = 80, 82, and 84, the admixture of non-collective components has been taken into account and parameters have been calculated for a number of $2^+$ and $3^-$ levels. Energies, transition probabilities, and quadrupole moments have been determined. (3 tables) (SDF)

**29842** CALCULATION OF ICCs FOR MAGNETIC TRANSITIONS WITH ALLOWANCE FOR THE QUADRATURE INTERACTION BETWEEN THE NUCLEUS AND THE ATOMIC SHELL. Borisoglebskii, L. A.; Tesevich, B. I.; Shulyakovskii, G. S. (Belorussian State Univ., Minsk). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 104-107(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2581-2584 (1974).

The effect of the nuclear quadrupole moment on the internal conversion coefficient for magnetic transitions is considered. It is shown that, in the case of $^{175}_{71}$Lu (Q = 8 barn), the magnetic ICC's can undergo a maximum change of 0.4%. (2 tables) (auth)

**29843** COEXISTENCE OF SPHERICAL AND DEFORMED STATES IN NUCLEI WITH ODD MASS NUMBERS. Peker, L. K.; Sigalov, V. M. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 150-152(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2633-2636 (1974).

The coexistence of spherical and deformed states in odd nuclei is examined with attention given to N = 88 and N = 89 nuclei. The discovery of this phenomenon in $^{151}$Sm, $^{149}$Nd, $^{153}$Gd, and $^{155}$Dy is reported. (2 figures) (SDF)

**29844** DECAY OF $^{166}$Ho. Grigor'ev, E. P.; Zolotavin, A. V.; Kamynov, Sh. V. (Leningrad State Univ.). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 30-34(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2499-2504 (1974).

The conversion-electron, $\beta$, and $\gamma$-ray spectra following the decay of $^{166}$Ho (T = 26.74 hr, $I^\pi = 0^-$) have been measured. The conversion-electron and $\beta$ spectra were measured with a UMB-2 magnetic prism spectrometer, and the $\gamma$-ray spectrum, with a 30 $cm^3$ Ge(Li) detector. (3 figures) (auth)

**29845** EXCITED STATES OF $^{188}$Os, E0 TRANSITIONS. Belyaev, B. N.; Vasilenko, S. S.; Kaminker, D. M.; Sergeenkov, Yu. V. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 35-39 (1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2505-2510 (1974).

The $\gamma$-ray, internal-conversion electron, and pair-conversion positron spectra of $^{188}$Re have been measured, and quantum numbers have been determined for some highly excited levels of $^{188}$Os. The reduced transition probability ratio for E0 and E2 transition has been obtained as X(E0/E2) = 0.24 ± 0.05 for the $0^+$ state at 1765.1 and 1086.2 keV. (3 tables, 1 fig.) (auth)

**29846** DECAY OF $^{171}$Lu AND THE LEVEL SCHEME FOR $^{171}$Yb. Bonch-Osmolovskaya, N. A.; Vylov, Ts.; Gromov, K. Ya.; Khaminov, A. Sh. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 45-51(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2516-2523 (1974).

The methods of $\gamma$- and $\beta$-ray spectroscopy have been used to investigate the decay of $^{171}$Lu. The level scheme for $^{171}$Yb, known from the literature, is analyzed on the basis of improved and new data on the $\gamma$-ray, conversion-electron, and positron spectra, and a number of new states are introduced. The structures of some excited states of $^{171}$Yb are determined. (5 tables) (auth)

**29847** RADIATIONS FROM $^{153}$Ho DECAY. Aleksandrov, A. A.; Buttsev, V. S.; Vylov, Ts.; Grigor'ev, E. P.; Gromov, K. Ya.; Kalinnikov, V. G.; Lyatushinskii, A.; Stegailov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 20-24(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974. Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2487-2492 (1974).

Gamma-gamma coincidence experiments were performed to investigate the decay of $^{153}$Ho. It was possible to resolve a number of close doublets with the aid of a high resolution uniform magnetic field beta spectrograph, in particular, the multipole K conversion line of the complex transitions at 847 and 946 keV. Results for the observed gamma transitions are tabulated. (2 figures, 2 tables) (SDF)

**29848** PROTON STRIPPING AND PICKUP STUDY OF THE STRUCTURE OF $^{165}$Ho. Lewis, D. A. Ann Arbor, MI; Univ. of Michigan (1974). 163p. University Microfilms Order No. 75-10,217.

Thesis (Ph. D.).

The structure of the one-quasiparticle states below 1.6 MeV of excitation in $^{165}$Ho has been examined by the use of the ($^3$He,d) and (alpha, t) stripping reactions on $^{164}$Dy targets. Data from the $^{166}$Er(d,$^3$He) $^{165}$Ho pickup reaction provided complementary spectroscopic information for the states in $^{165}$Ho below 1.2 MeV of excitation. Angular distributions were measured for the ($^3$He,d) reaction from $0^0$ to $25^0$ and for the (d,$^3$He) reaction from $10^0$ to $35^0$. The bombarding energies were 46.5 MeV and 34.5 MeV respectively. One (alpha, t) spectrum was measured at $10^0$, E/sub alpha/ equals 45.5 MeV. Transitions to 23 levels were observed and 1 transfers and spectroscopic factors were obtained for 19 of these. Previous identification of members of the $^7/_2^-$[523], $^1/_2^+$[411], $^3/_2^+$[411], and $^7/_2^+$[404] bands was confirmed. New assignments include members of the $^1/_2^-$[541], $^5/_2^+$[402], and $^1/_2^+$[660] bands. Some of the observed transitions do not seem to correspond to levels predicted by the Nilsson model. Cross sections for six states were measurable in both stripping and pickup reactions yielding experimental values of $U^2$ and $V^2$. Spectroscopic information inferred from the data using a standard DWBA analysis is compared with the Nilsson-plus-pairing model with Coriolis effects included. The agreement is reasonably good but the model predictions for weaker states are often a factor of 2 or 3 too small. The data are then reanalyzed using a CCBA approach with improved form factors. Although the theoretical predictions are improved, many discrepancies still remain. Since good energy resolution and the ability to measure small cross sections were both required in order to perform the experiments, a thorough investigation of experimental line shapes was made. This resulted in a generalization of the current theories of energy straggling to include nuclear reactions. (auth)

**29849** DECAY OF THE 4.2-MIN $^{152}$Pm INTO LEVELS OF $^{152}$Sm. Wirth, G.; Kaffrell, N.; Chayawattanangkur, K.; Herrmann, G.; Seyb, K. E. (Mainz Univ. (F. R. Germany). Inst. fuer Kernchemie). Z. Phys., A; 272: No. 3, 291-300(Mar 1975).

7 figs.; 6 tabs.; 47 refs.

After bombardments of enriched $^{152}$Sm with 14-MeV neutrons, three isomers of $^{152}$Pm were observed with half-lives of 4.2 ± 0.2 min, 7.5 ± 0.2 min and 15.0 ± 1.0 min. Sources of pure 4.2-min $^{152}$Pm were obtained by separating the promethium from its parent 11-min $^{152}$Nd. The beta and gamma radiations of the 4.2-min $^{152}$Pm were investigated using semiconductor and scintillation spectrometers. Most of the $\gamma$-ray transitions could be placed in a level scheme for $^{152}$Sm. Especially interesting is a level at 1,083 keV for which the assignment $I,\pi = 0^+$ is proposed. (auth)

**29850** TRANSITIONAL NUCLEI: $^{150}$Sm FROM THE DECAY OF $^{150}$Pm. Kalfas, C. A.; Xenoulis, A.; Paradellis, T. (Democritus Nuclear Research Center, Athens). J. Phys., G (London); 1: No. 6, 613-622(1 Aug 1975).

Gamma-gamma directional correlation techniques employing a Ge(Li)NaI(Tl) system were used to investigate the de-excitation mechanism and character of several states in $^{150}$Sm, following the decay of $^{150}$Pm. Spins of certain levels and multipole mixing ratios of transitions from the quadrupole and octupole quasi-vibrational bands were determined. The experimental mixing ratio values are compared with the theoretical prediction of Kumar and with corresponding values in neighboring nuclei. (auth)

**29851** 384 keV $\beta$ TRANSITION IN THE DECAY OF $^{177}$Lu. Reddy, B. V.; Raju, M. L. N.; Sastry, D. L. (Andhra Univ., Waltair, India). J. Phys., G (London); 1: No. 6, 638-645(1 Aug 1975).

In the decay of $^{177}$Lu, the 384 keV $\beta$-113 keV $\gamma$ directional correlation is measured and found to be isotropic within the experimental errors. The results are in accordance with the applicability of the $\xi$ approximation to the 384 keV $\beta$ transition and are in agreement with the Nilsson model predictions. (auth)

**29852** A NEW HIGH-SPIN ISOMER IN $^{154}$Eu. Castaneda, C.; Smith, H. A. Jr.; Ward, T. E. (Indiana Univ., Bloomington (USA)). Phys. Lett., B; 57: No. 4, 335-337(21 Jul 1975).

A new 48.2 ± 1.7 min isomeric state in $^{154}$Eu was produced through the $^{154}$Sm(p,n) reaction at $E_p$ = 11 MeV. Excited states

in $^{154}$Eu with lifetimes of 4.1 ± 0.4 μs and 50 ± 10 ns were also observed at $E_x$ = 68 and 101 keV, respectively. (auth)

# Nuclear Properties and Reactions, 190 ≤ A ≤ 219

*Refer also to abstracts 29656, 29691, 29721, 29789, 29824, 29836, 29880, and 29986.*

**29853** (JU-RR-74/6) ELECTROMAGNETIC TRANSITION RATES IN $^{208}$Pb. Kortelahti, M.; Pakkanen, A.; Kantele, J. (Jyvaeskylae Univ. (Finland). Dept. of Physics). Sep 1974. 19p. Dep. NTIS (US Sales Only) $4.00.

Intensities of γ-ray transitions in $^{208}$Pb have been determined by double and triple coincidence studies of the decay of $^{208}$Tl ($ThC''$). The measured branching ratios are compared with those calculated from theoretical and empirical wave functions of the levels of $^{208}$Pb. The empirical wave functions give a better agreement with the present results. In the calculations, use was made of experimentally determined or theoretical M1 and E2 single-particle transition matrix elements. (3 figures, 2 tables) (auth)

**29854** HADRONIC EXCITATION OF THE GIANT RESONANCE REGION OF $^{208}$Pb. Halbert, E. C.; McGrory, J. B.; Satchler, G. R. (Oak Ridge National Lab., Tenn. (USA)); Speth, J. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). Nucl. Phys., A; 245: No. 2, 189-204(30 Jun 1975).

Calculations have been made of the inelastic spectra leaving $^{208}$Pb with excitation energies in the giant resonance region (approximately 9 to 15 MeV) following the inelastic scattering of 60 MeV protons and 115 MeV alphas. Particle-hole wave functions obtained in the RPA were used, together with an effective interaction between the projectile and each target nucleon. A "giant resonance" peak is predicted with excitation energy and strength similar to those observed. While the predominant multipole is quadrupole, considerable L equals 4 and some L equals 0 and L equals 6 strength is concentrated in the same region. Because of this, the angular distributions are smoothed out. The use of the collective model to describe these excitations is discussed. The electric transition strengths B(EL) and the inelastic cross sections are contrasted and the use of multipole sum rules is criticized. (auth)

**29855** COMPLEX LOCAL EQUIVALENTS TO IMAGINARY NON-LOCAL POTENTIALS: NEUTRON SCATTERING FROM $^{208}$Pb. Mackellar, A. D. (Kentucky Univ., Lexington (USA)); Schenter, R. E. (Hanford Engineering Development Lab., Richland, Wash. (USA)); Schadel, H. M. (Princeton Univ., N. J. (USA)); Lev, A.; Beres, W. P. (Wayne State Univ., Detroit, Mich. (USA)). Nucl. Phys., A.; 225: No. 1, 61-79(4 Jun 1974).

The complex equivalent local potential to an imaginary non-local potential obtained in a weak coupling particle vibration model for low energy s-wave neutron elastic scattering from $^{208}$Pb is presented. The local potential contains a non-zero real part, is surface peaked, and exhibits resonances. The equivalent local potential and damping of the local wave function relative to the non-local wave function depend on the strength of the Woods–Saxon real central potential also present in the Schroedinger equation. (auth)

**29856** HALF-LIFE OF THE $4^+$ EXCITED STATE IN $^{192}$Pt. Awwad, Z.; El-Aasser, M. R. (Atomic Energy Establishment, Cairo). ATOMKI (At. Kut. Intez.) Kozl.; 17: No. 2, 171-177 (1975). (In English and Hungarian).

$(5 \pm 4) \times 10^{-12}$ sec. half-life has been found for the 785 keV $4^+$ excited state in $^{192}$Pt. The measurements have been performed in an electron-electron coincidence spectrometer by means of a delayed coincidence technique. The reduced transition probability was deduced. (3 figures) (auth)

**29857** SPIN VALUES OF THE LOW LYING NUCLEAR LEVELS OF $^{201}$Hg. Hofmann, S.; Walcher, D. (Technische Univ. Darmstadt (F. R. Germany). Inst. fuer Kernphysik). Z. Phys., A; 272: No. 4, 351-354(1975).

4 figs.; 1 tab.; 12 refs.

Gamma-gamma directional correlations have been investigated for the cascades of 135-30 keV and 135-32 keV in $^{201}$Hg from the decay of $^{201}$Tl. A combination of NaI(Tl) and Si(Li) detectors was used for the experiments. Spin values of I = ½, ³⁄₂, and ½ have been assigned to 1.58, 32.19, and 167.49 keV energy levels. In addition, the relative intensities of the γ rays have been measured with a Ge(Li) detector system. The results are 2.2 ± 0.2, 2.2 ± 0.2, 26.5 ± 1.3, 1.6 ± 0.1 and 100 for the γ rays of 30.60, 32.19, 135.34, 165.88, and 167.43 keV energies, respectively. (auth)

**29858** HIGH RESOLUTION STUDY OF PROTON INELASTIC SCATTERING FROM $^{207}$Pb, $^{208}$Pb, AND $^{209}$Bi. Wagner, W. T. East Lansing, MI; Michigan State University (1974). 201p. University Microfilms Order No. 75-7274.

Thesis (Ph. D.).

Angular distributions of states in $^{207}$Pb, $^{208}$Pb, and $^{205}$Bi excited by 35 MeV protons have been measured with a resolution of 5 to 10 keV. Collective model calculations enabled the l-transfers of many transitions to be identified. In $^{208}$Pb, calculations for a number of the observed states were made with both phenomenologically determined and theoretically calculated wave functions. Both central and non-central two-body forces were used in the analysis and the effects of knock-on exchange were accounted for. The large number of observed unnatural parity states permitted the role of non-central forces in these inelastic transitions to be investigated. The states which are strongly populated in both the (p,p') and (e,e') reactions were analyzed in a microscopic theory using the electron scattering form factors. The possibility of excitation of giant magnetic dipole levels was also investigated. In the nuclei $^{207}$Pb and $^{209}$Bi the transitions to the identified single particle levels were compared to calculations involving valence orbitals with both central and non-central interactions. The effects of core polarization in excitation of these states were investigated with a microscopic model using an expanded shell model basis. In the framework of a weak coupling model, the transitions to many levels in these odd mass nuclei were compared to excitations in $^{208}$Pb. (auth)

**29859** DISTORTED WAVE THEORY OF MULTI-STEP PROCESSES IN DIRECT REACTIONS WITH APPLICATIONS TO SUCCESSIVE NUCLEON TRANSFER MECHANISMS. Managoli, V. A. Tallahassee, FL; Florida State University (1974). 159p, University Microfilms Order No. 75-12,653.

Thesis (Ph. D.).

A general and an exact distorted wave "On-Shell Method" is formulated to describe the multi-step processes in direct nuclear reactions. This method makes use of the non-linear form of the distorted wave transition matrix equation corresponding to a dispersion theory approach first developed by Robson. The generalized optical theorem for two-potential-scattering is used to eliminate the multi-step "off-shell" contributions entirely. The on-shell method is applied to the successive transfer mechanism in the (p,t) reactions on $^{206}$Pb target nucleus. It is shown that the two-step p yields d yields t mechanism provides a good description of the forbidden (in the zero-range one-step DWBA sense) transition leading to the unnatural parity $3^+$ state in the $^{208}$Pb nucleus. The inclusion of the singlet state of the deuteron with an appropriate Q-value corresponding to the binding energy of –70 KeV in the calculations does not spoil the good fit obtained with the triplet deuteron contributions alone. The calculations of the allowed transitions to the $0^+$, $2^+$, $4^+$ states in $^{208}$Pb nucleus show in general that the successive transfer mechanism p yields d yields t alone is not sufficient to account for the data, showing the need to include other multi-step processes. In the case of the allowed transition to the $0^+$ state, although the reproduction of the angular distribution shape is fair, the magnitude of the cross-section is smaller by a factor of around 6. The fit to the angular distributions is rather poor in the case of the $2^+$ and $4^+$ transitions. (auth)

**29860** SHELL-MODEL CALCULATIONS OF TWO TO FOUR IDENTICAL-"PARTICLE" SYSTEMS NEAR $^{208}$Pb. McGrory, J. B. (Oak Ridge National Lab., Tenn. (USA)); Kuo, T. T. S. (State Univ. of New York, Stony Brook (USA)). Nucl. Phys., A; 247: No. 2, 283-316(4 Aug 1975).

The structure of the nuclei $^{204-206}$Pb, $^{210-212}$Pb, $^{210}$Po, $^{211}$At, and $^{212}$Rn is studied in terms of conventional nuclear shell models. An inert $^{208}$Pb core is assumed, and active particles (holes) are distributed in the low-lying single-particle (hole) orbits. Experimental single-particle energies are used for the one-body part of the effective residual interaction. Realistic interaction matrix elements developed for this mass region by Kuo and Herling are used for the matrix elements of the two-body part of the residual interactions. As much as possible, other effective one-body operators for electromagnetic observables are derived from experimental data on the single-particle (hole) nuclei $^{207}$Pg, $^{209}$Pb, and $^{209}$Bi. Observables treated are ground-state binding energies, excitation energies, strengths for one- and two-particle transfers, and E2 and M1 observables. Generally, excellent agreement is found. The configuration mixing calculations do not remove anomalies in the magnetic moments of excited states in $^{206}$Pb and $^{212}$Rn. Many states in these nuclei are predicted by the models which have not been observed as yet. It is found that a truncation scheme for doubly even nuclei treated here in which only seniority-0 and seniority-2 states are allowed is potentially very useful. (auth)

**29861** $^{208}$Pb($\alpha$,$^3$He)$^{209}$Pb REACTION AT 58 MeV. Tickle, R.; Gray, W. S. (Michigan Univ., Ann Arbor (USA). Cyclotron

Lab.). Nucl. Phys., A; 247: No. 2, 187-194(4 Aug 1975).

The $^{208}$Pb(alpha,$^{3}$He)$^{209}$Pb reaction at 58 MeV has been used to search for high-spin states in $^{209}$Pb. Only three levels are excited with appreciable intensity: the ground state (2g/sub 9/2) and levels at 0.781 (1i/sub 11/2) and 1.426 MeV (1j/sub 15/2). The angular distributions for these levels have been measured and analyzed using standard DWBA calculations to obtain spectroscopic strengths. The $^{208}$Pb(alpha,alpha) elastic scattering was measured, and optical parameters were deduced from the data. A normalization value N equals 50 yields spectroscopic values which are close to the values measured in the (d,p) reaction. The (alpha,$^{3}$He) reaction should easily pick out any appreciable components of the j/sub 15/2 shell model state, which weak-coupling calculations predict should be fragmented. However, only three weak transitions previously seen in a (d,p) experiment are observed. (auth)

**29862** NUCLEAR ORIENTATION OF 2.3-d/sup 198m/Au. Mahnke, H. E.; Kaindl, G.; Bacon, F.; Shirley, D. A. (California Univ., Berkeley (USA). Dept. of Chemistry). Nucl. Phys., A; 247: No. 2, 195-202(4 Aug 1975).

The magnetic hyperfine interaction of the T/sub 1/2/ equals 2.3-d high-spin isomeric state of $^{198}$Au has been measured in host metals of iron and nickel at temperatures down to 4 mK by using the thermal-equilibrium nuclear-orientation technique. The resulting value for the magnetic moment, mu equals (+) 5.55 +- 0.35 n.m., strongly supports an interpretation of this state as a [pi $h^{11}/_{2}$; nu $i^{13}/_{2}$] 12$^{-}$ configuration analogous to $^{196}$/sup m/Au and $^{200}$/sup m/Au. The observed gamma-ray anisotropies are in agreement with the recently proposed decay scheme of $^{198}$/sup m/Au; for the E2/M1 mixing ratio of the 204-keV gamma-transition, they result in a value of delta equals -0.10 +- 0.05. (auth)

**29863** GAMMA-RAYS OF THE (8.83 d) DECAY OF $^{206}$Po. Lingeman, E. W. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). Radiochim. Acta; 20: No. 3, 142-144 (1973).

The gamma-ray spectrum of $^{206}$Po was measured with a Compton suppression spectrometer. A total of 55 gamma-rays were found to belong to the decay of $^{206}$Po. (GE)

**29864** EXCITATION OF LIGHT Hg NUCLEI IN THE DECAY OF Tl. Fenyes, T.; Mahunka, I.; Mate, Z. (Magyar Tudomanyos Akademia Atommag Kutato Intezete, Debrecen); Jolos, R. V. (Joint Inst. for Nuclear Research, Dubna (USSR)); Paar, V. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)). Nucl. Phys., A; 247: No. 1, 103-125(28 Jul 1975).

Recent YASNAPP (Dubna) experimental results on the decay of light thallium isotopes ($^{188,189,190,191,192,193,194,195,197}$Tl) are briefly reviewed. From the systematics of available experimental data on the excited states of light even and odd Hg nuclei general conclusions are drawn. New calculations have been performed for the energy levels and electromagnetic properties of light even Hg nuclei by coupling two valence-shell proton holes (cluster) to the quadrupole core vibration. The properties of light odd Hg nuclei have been calculated on the basis of the pairing-plus-quadrupole-residual-interaction model by coupling one neutron quasi-particle to the anharmonic quadrupole core vibration. These nuclei have also been considered by coupling a three-neutron-hole cluster to vibrations. The theoretical results are qualitatively similar in both representations and explain many experimental data. (auth)

**29865** MOESSBAUER DETERMINATION OF THE E2/M1 MIXING RATIO OF THE 77 keV TRANSITION IN $^{197}$Au AND OF THE SIGN OF THE ELECTRIC FIELD GRADIENT IN $KAu(CN)_2$. Prosser, H.; Wagner, F. E.; Wortmann, G.; Kalvius, G. M.; (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.); Waeppling, R. (Uppsala Univ. (Sweden). Fysiska Institutionen). Hyperfine Interactions; 1: No. 1, 25-32(Jun 1975).

A Moessbauer measurement of the E2/M1 mixing ratio of the 77 keV transition in $^{197}$Au yielded $\delta = -0.352 \pm 0.005$. With this result, Moessbauer absorption spectra of $KAu(CN)_2$ single crystals show that the electric field gradient at $^{197}$Au in this compound is negative. This implies that the field gradient is mainly produced by $6p_{\frac{1}{2}}$ electrons. The data also indicate a large vibrational anisotropy of Au in $KAu(CN)_2$. (auth)

**29866** TWO-NUCLEON TRANSFER PROCESSES IN THE LEAD REGION. Faessler, A.; Gruemmer, F.; Krmpotic, F.; Osterfeld, F. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik); Plastino, A. (La Plata Univ. Nacional (Argentina). Facultad de Ciencias Exactas). Nucl. Phys., A; 245: No. 3, 466-478(7 Jul 1975).

In the lead region a theoretical study of two-nucleon transfer processes is made with the help of the generator-coordinate method. Both two-proton and two-neutron transfer reactions are described. The two-phonon pairing vibrational states in $^{208}$Pb are especially considered. Energies, relative cross sections and angular distributions are presented and compared, when possible, with experiments. (auth)

**29867** ANGULAR DISTRIBUTIONS OF PHOTOPROTONS FROM $^{208}$Pb. Shoda, K.; Sugawara, M.; Saito, T.; Miyase, H. (Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science). Nucl. Phys., A; 246: No. 2, 357-364(21 Jul 1975).

Angular distributions of photoprotons following the (e,e'p) reaction in $^{208}$Pb have been measured at incident energies of 25.0 MeV and 40.0 MeV. The proton energy distributions were measured at several angles, and the angular distributions were obtained for several proton energy ranges. Proton groups at around 11.0 MeV and 15.3 MeV are separated for the angular distributions, and the results show almost isotropic distributions, which indicate that these proton groups are emitted through IAR. The angular distributions for other slowly varying parts of the proton spectra proved strongly asymmetrical, indicative of interference between E1 and E2 transitions. (auth)

**29868** PHOTOPROTON REACTIONS ON $^{208}$Pb. Shoda, K.; Oikawa, S.; Saito, T.; Miyase, H.; Suzuki, A. (Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science). Nucl. Phys., A; 246: No. 2, 365-379(21 Jul 1975).

Photoproton energy distributions have been measured for the (e,e'p) reaction at a number of bombarding energies. The results are used to obtain the (e,e'p) cross sections and isochromats. The (e,e'p) cross sections are analyzed to get the ($\gamma$,p) cross sections. The results and ($\gamma$,p) cross sections show a strong resonance around 25.0 MeV, whose energy and integrated cross section agree well with theory for IAR. Proton spectra emitted through the IAR are extracted from the photoproton spectra and also from the isochromats. Strong proton groups are found at around 15.3 MeV and 11 MeV corresponding to the $h_{11/2}$ proton hole state at 1.3 MeV and also neutron particle-hole states around 6 MeV in the residual nucleus. The result is in good agreement with estimates obtained from proton scattering on $^{208}$Pb, showing the configuration of the IAR states. (auth)

**29869** GAMMA DECAY OF PARTICLE-CORE STATES IN $^{209}$Pb. Duennweber, W.; Cosman, E. R.; Grosse, E.; Hering, W. R.; von Brentano, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Nucl. Phys., A; 247: No. 2, 251-273(4 Aug 1975).

A $\gamma$-decay scheme for levels in $^{209}$Pb up to 4.13 MeV of excitation has been established by means of the reaction $^{208}$Pb(d,p$\gamma$)$^{209}$Pb. In high-efficiency p-$\gamma$ coincidence measurements, $\gamma$-cascades have been observed from the single-particle states and from core-excited states with very small single-particle strength. Assuming a qualitative validity of the weak-coupling model, spins and main configurations of particle-core states can be deduced from their $\gamma$-decay. The $J^{\pi}$ = ($^{3}/_{2}^{-}$, $^{5}/_{2}^{-}$ or $^{7}/_{2}^{-}$, $^{11}/_{2}^{-}$, $^{15}/_{2}^{-}$) members of the $g_{\frac{9}{2}} \otimes 3^{-}$ multiplet could be located. A systematic manner of doublet splitting is found for the lowest states with main configuration $(p_{\frac{1}{2}})^{-1} \otimes ^{210}$Pb ($0^{+}$, $2^{+}$, $4^{+}$, $6^{+}$, $8^{+}$). A new decay branch of the $g_{\frac{9}{2}}$ single-particle state is attributed to an admixture of quadrupole core vibration. (auth)

**29870** ANALYSIS OF THE DATA ON THE MAGNETIC MOMENTS OF NUCLEI IN THE VICINITY OF LEAD. Isakov, V. I.; Sliv, L. A. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 1-14(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR(29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2466-2481 (1974).

A review is presented of the attempts to calculate magnetic moments of quasiparticle states and transition probabilities in the region of doubly magic lead. Two effects have been emphasized: the spin polarization of the core, which leads to the excitation of particle-hole pairs to levels of spin-orbit doublets, and the exchange current effect. A comparison of diagonalization and perturbation theory results is included. (3 figures, 8 tables) (SDF)

**29871** GAMMA-GAMMA DIRECTIONAL CORRELATION MEASUREMENTS IN $^{192}$Os. Becker, J.; Beshai, S.; Eriksson, L.; Gidefeld, L. (Stockholm Univ. (Sweden). Fysiska Institutionen). Z. Phys., A; 273: No. 1, 43-45(May 1975).

1 fig.; 2 tabs.; 14 refs.

E2/M1 mixing ratios of transitions in $^{192}$Os were determined by the gamma-gamma directional correlation technique. (auth)

**29872** FUSION AND FISSION INDUCED BY HEAVY IONS. Oganessian, Yu. T. (Joint Inst. for Nuclear Research, Dubna (USSR)). pp 221-252 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

Some problems associated with the mechanism of compound nucleus formation in reactions induced by ions with mass ≥ 40 amu are considered. Experiments to synthesize neutron-deficient nuclei with Z = 100, 104 and 106 by bombarding Pb isotopes with 40-Ar, 50-Ti and 54-Cr ions are described. Some data on delayed fission of neutron-deficient Am isotopes in the Pb + Al reaction are given. The properties of heavy nuclei are discussed in terms of the present-day fission theory. The possibilities of synthesizing elements with Z > 106 are investigated. (auth)

**29873** CROSS-SECTIONS FOR THE BINARY AND TERNARY FISSION OF URANIUM AND LEAD INDUCED BY 14 GeV PROTONS. Todorovic, Z.; Antanasijevic, R.; Juric, M. (Inst. of Physics, Belgrade). Fizika (Zagreb); 6: No. 4, 219-223(Dec 1974).

The cross-sections for the binary and ternary fission of uranium and lead induced by 14 GeV protons have been computed. A solid-state plastic detector (macrofol) was used as the detector of fission fragments. (4 figures) (auth)

## Nuclear Properties and Reactions, A ≥ 220

*Refer also to abstracts 29836, 29873, and 29895.*

**29874** (JINR-E15-9040) FISSION PROBABILITY OF NUCLEUS OF $^{232}$Th MESOATOM. Cojocaru, V.; Gavrilov, Yu. K.; Chwan, K. S.; Krogulski, T.; Kuznetsov, V. D.; Ortlepp, H. G.; Polikanov, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

The fission probability of the nucleus of the $^{232}$Th muonic atom has been measured. The fission yield was measured simultaneously with the intensity of 5g–4f transition in the muonic atom $^{232}$Th. A good agreement with previous results obtained in measurements with the fission chamber and evident disagreement with the photoemulsion data has been obtained. (2 tables, 7 figures) (auth)

**29875** (TID-3317-S5) TRANSPLUTONIUM ELEMENTS. A Bibliography. Stuber, C. E. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Sep 1975. 167p. Dep. NTIS $7.60.

This bibliography comprises 994 references on the transplutonium elements compiled through the period ending December 31, 1974. The references were retrieved from the Nuclear Science Abstracts (NSA) data base using a computerized information retrieval system. Part I includes 962 references dealing with the production and chemical, nuclear, physical, and biological properties and health and safety aspects of elements with Z greater than or equal to 95. Part II includes 32 references dealing with the natural occurrence of the transplutonium elements. This collection of references is concerned with attempts to locate or prove the existence of the transplutonium elements in nature. Author, report number, and subject indexes are included. (SDF)

**29876** STRUCTURE OF THE ANGULAR ANISOTROPY AND OF THE FISSION CROSS SECTION OF $^{233}$U(n, f). Shpak, D. L.; Smirenkin, G. N. Yadern. Fiz.; 21: No. 4, 704-707(Apr 1975). (In Russian).

Glass detectors were used to study the angular anisotropy of $^{233}$U fission fragments and the energy dependence of $^{233}$U fission cross section to the cross section of $^{235}$U fission induced by 0.015–2.00 MeV neutrons. The energy dependence of the angular anisotropy shows a stepped form of the parameter $K_0^2$. At 0.2–0.8 MeV neutron energy the energy dependence of the ratio of $^{233}$U fission cross section that of $^{235}$U has a resonant structure. (1 figure) (auth)

**29877** NUCLEON PAIRING EFFECT ON THE YIELDS OF FISSION FRAGMENTS. Okolovich, V. N.; Pavlov, A. F.; Tishin, A. S. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 21: No. 4, 699-703(Apr 1975). (In Russian).

The measured mass distributions of fragments from $^{232}$Th fission induced by 23.5, 27, 30 and 35 MeV $\alpha$ particles and the experimental data from other papers ($^{232}$Th + $\alpha$ and $^{235}$U + $n$) are used to analyse the energy behavior of the yields of symmetrical and asymmetrical mass fragments. The assumption is made that the nucleon pairing affects the yields of fragments. The cusp is observed in the energy behavior of the yields, which is correlated with the similar singularity in other properties of fission nuclei. The cusp is considered as the manifestation of a phase transition of the nucleus in the saddle point from the superfluid state to the normal (Fermi gas) state. (2 figures) (auth)

**29878** NEAR THRESHOLD PHOTOFISSION AND PHOTONEUTRON EMISSION IN $^{238}$U AND $^{232}$Th. Dickey, P. A. Urbana, IL; University of Illinois (1975). 173p. University Microfilms Order No. 75-14,101.

Thesis (Ph. D.).

Bremsstrahlung photons produced by electrons from the University of Illinois superconducting microtron have been used to induce photofission and photoneutron emission near the fission and neutron emission thresholds in the even-even nuclei $^{238}$U and $^{232}$Th. Coincident detection of the reaction products and momentum analysis of the post bremsstrahlung electrons in the bremsstrahlung monochromator defined the photon energy to within 1.0-1.7 percent (full width) from 5 to 8 MeV. The time of flight of photoneutrons and fission neutrons was measured and the two components of the neutron yield were separated on the basis of their characteristic energy spectra. The photofission cross sections were obtained from the observed fission neutrons using values of anti nu, the fission neutron multiplicity, from the literature. (auth)

**29879** RELATIVE ABUNDANCES FOR SIX DELAYED NEUTRON GROUPS FROM REACTOR NEUTRON-INDUCED FISSION OF $^{231}$Pa. Anoussis, J. N.; Perricos, D. C.; Chrysochoides, N. G.; Mitsonias, C. A. (Democritus Nuclear Research Center, Athens (Greece). Reactor Dept.). Radiochem. Acta; 20: No. 3, 118-119(1973).

2 tabs.: 14 refs.

Relative delayed neutron yields from reactor neutron-induced fission of $^{231}$Pa are reported. The delayed neutron decay curve is resolved into six groups having half-lives of around 56, 24, 16, 6, 4.5, and 2 sec and the corresponding abundances, which fit the curve best are 10.42 ± 0.05% ($^{87}$Br), 15.45 ± 0.31% ($^{137}$I), 17.82 ± 0.52% ($^{88}$Br), 5.30 ± 1.65% ($^{138}$I, $^{93}$Rb), 25.10 ± 2.58% ($^{89}$Br) and 25.90 ± 2.74% ($^{85}$As, $^{90}$Br, $^{93}$Kr, $^{94}$Rb, $^{135}$Sb, $^{139}$I, $^{143}$Cs) respectively. (auth)

**29880** SMALL ANGLE NEUTRON SCATTERING AT 4.3 MeV FROM HEAVY ELEMENTS. McFadden, R. C. Vancouver, Canada; University of British Columbia (Canada)(1974). vp. National Library of Canada, Ottawa.

Thesis (Ph. D.).

The associated particle technique was employed to produce a collimated beam of 4.3 MeV neutrons from the reaction D (d,n)$^3$He. A rotating target assembly permitted the use of thin deuterated polyethylene deuterium targets. The use of a position sensitive detector in the associated particle technique was demonstrated. Data was accumulated by an on-line computer system. The differential scattering cross section for 4.3 MeV neutrons was measured for scattering samples of uranium bismuth, and lead over the angular range of 5° to 15°. The data were corrected for the effects of finite angular resolution, neutron multiple scattering, air scattering, and neutron inelastic scattering. The experimental scattering cross sections were in agreement with those calculated on the basis of a nuclear optical model interaction plus an electromagnetic Schwinger interaction. No evidence was found to substantiate anomalous cross sections at small angles. (auth)

**29881** DETERMINATION OF FRAGMENT ISOTOPIC YIELDS IN THE FISSION OF $^{252}$Cf ACCOMPANIED BY LIGHT CHARGED PARTICLES. Ajitanand, N. N.; Choudhury, R. K.; Kapoor, S. S. (Bhabha Atomic Research Centre, Bombay (India)). Nucl. Phys., A; 246: No. 2, 505-514(21 Jul 1975).

High-resolution measurements of prompt $\gamma$-rays emitted from fission fragments accompanied by light charged particles (LCP) and those emitted from normal binary fission fragments in $^{252}$Cf fission were simultaneously carried out using a 30-cm$^3$ Ge(Li) detector. A "sandwich" type of arrangement in the source–detector assembly was used to eliminate Doppler broadening of the $\gamma$-ray lines in both cases. About thirty $\gamma$-ray lines were assigned to specific fission fragments by comparison with the published results for binary fission, and the ratios of intensities of these $\gamma$-ray lines in LCP fission and binary fission were determined. Assuming that $2^+ \rightarrow 0^+$ transition intensities of doubly even isotopes are a measure of their yields, the yields of several such isotopes in LCP accompanied fission relative to that in binary fission were obtained. (auth)

**29882** NUCLEAR CHARGE DISTRIBUTION OF MASS-SEPARATED ISOBARS FROM THERMAL-NEUTRON-INDUCED FISSION OF $^{235}$U. Clerc, H. G.; Schmidt, K. H.; Wohlfarth, H.; Lang, W.; Pferdekaemper, K. E.; Jungmann, R. (Technische Univ. Darmstadt (F. R. Germany). Inst. fuer Kernphysik); Schrader, H.; Asghar, M.; Bocquet, J. P.; Siegert, G. (Institut Max von Laue – Paul Langevin, 38 – Grenoble (France)). Nucl. Phys., A; 247: No. 1, 74-90(28 Jul 1975).

The nuclear charge distribution of fission products with mass numbers A = 90, 91, 94, 99, 100, 101 and 104 provided by the mass separator "Lohengrin" was measured. Adjacent elements in the group of the light fission products could be separated by their different energy loss in a carbon absorber. The Z-yields were

found to be strongly dependent on the kinetic energy of the fission products. The widths of the nuclear charge distributions are very small, in general, and strongly dependent on A as well as on the kinetic energy. The influence of the neutron evaporation and odd–even effects are clearly detected. An asymmetric nuclear charge distribution was found for A = 104, indicating the suppression of fission fragments with Z = 43. The average nuclear charges of the fission products at their average kinetic energy are in good agreement with the results from measurements of the number of $\beta$-decays and K x-ray measurements. The average nuclear charge of the isobar A = 132 was measured at its average kinetic energy with a calibrated secondary electron detector to be Z = 51.14 ± 0.15, which is in very good agreement with the radiochemical results. Thus previous physical measurements indicating a large independent yield for the doubly magic nucleus $^{132}$Sn could not be confirmed. (auth)

**29883** MUON INDUCED FISSION OF $^{237}$Np, $^{239}$Pu AND $^{242}$Pu. Aleksandrov, B. M.; Buklanov, G. V.; Fromm, W. D.; Gansorig, D.; Krivokhatskii, A. S.; Krogulskii, T.; Polikanov, S. M.; Sabirov, B. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). Phys. Lett., B; 57: No. 3, 238-240(7 Jul 1975).

The absolute yields for prompt and delayed fission induced by negative muons in $^{237}$Np, $^{239}$Pu and $^{242}$Pu have been measured and compared with photofission data. (auth)

**29884** THERMAL NEUTRON CAPTURE CROSS SECTION AND RESONANCE INTEGRAL OF $^{227}$Ac. Monsecour, M.; de Regge, P. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). J. Inorg. Nucl. Chem.; 37: No. 9, 1841-1843(Sep 1975).

Small samples of purified $^{227}$Ac, deposited on aluminium foils, were irradiated together with $^{59}$Co flux monitors in the BR1 reactor. The absolute activity of $^{228}$Ac induced in the targets by the irradiation with and without cadmium cover was measured with a calibrated Ge(Li) gamma spectrometer. Assuming a thermal neutron cross section of 37.4 barn and a resonance integral of 70.0 barn for the reaction $^{59}$Co $(n,\gamma)^{60+60m}$Co values of respectively 762 ± 29 barn and 1017 ± 103 barn were obtained. The quoted errors include all systematic and random errors of the procedure. (auth)

**29885** RANGES OF $^{140}$Ba FROM THERMAL NEUTRON INDUCED FISSION OF $^{235}$U ALONG THE DIFFERENT CRYSTALLOGRAPHIC DIRECTIONS OF ALUMINIUM SINGLE CRYSTAL. Sharma, T.; Mukherji, S. (Indian Inst. of Tech., Kanpur). J. Inorg. Nucl. Chem.; 37: No. 9, 1845-1849(Sep 1975).

The ranges of $^{140}$Ba from the thermal neutron induced fission of $^{235}$U along the various low indices crystallographic directions of aluminium single crystal have been determined by using a thin-target thin-catcher method. A two-step electrochemical method has been used to remove thin layers from the electropolished surface of the aluminium single crystal. Contrary to the expected maximum value for the penetration depth of heavy ions in the most favored direction ((110)) in aluminium single crystal, the ranges are found to be in the increasing order: ((111)) > ((110)) > ((100)). (auth)

**29886** PHOTOFISSION OF $^{232}$Th. Hogan, J. C. Las Cruces, MX; New Mexico State Univ. (1974). 175p. University Microfilms Order No. 75-15,897.

Thesis (Ph. D.).

The mass-yield distribution of fission products following photofission of $^{232}$Th using peak bremsstrahlung energies of 9, 15 and 38 MeV were measured by gamma spectrometry for 25 mass chains in the light and heavy mass wings. Fission yields for mass chains 85, 87, 88, 138 and 146 were measured for the first time for the photofission of $^{232}$Th in this work. Several fractional chain yields were measured and various postulates of charge distribution were tested to correlate the experimental data. The Nethaway modified empirical Coryell method showed the best correlation with the observed charge distributions. Evidence for fine structure was observed from the 9 and 15 MeV irradiation in both the heavy and light mass wings with peaks occurring at A equals 134 and A equals 93, respectively. The inner portion of the mass wings both exhibited increasing splay as the irradiation energy was increased, thus indicating that symmetric fission was enhanced with increased energy. (auth)

**29887** EXCITED STATES OF $^{233}$Pa FOLLOWING THE ALPHA PARTICLE DECAY OF $^{237}$Np. Peterson, D. M. Raleigh, NC; North Carolina State Univ. (1973). 72p. University Microfilms Order No. 75-19,021.

Thesis (Ph. D.).

The gamma-ray transitions between the energy levels of $^{233}$Pa were observed following the alpha particle decay of $^{237}$Np. The gamma rays were measured using a new generation Ge(Li) detector, provided by ORTEC, which was able to provide the extremely high energy resolution which is necessary to separate some of the extremely complex peaks in the $^{233}$Pa transition spectrum. The gamma rays which were due to transitions in $^{233}$Pa were isolated from those of other competing modes in the radioactive $^{237}$Np source by requiring that an alpha particle be in coincidence with each gamma ray. Those gamma rays which satisfied this criterion were examined in more detail using two Ge(Li) detectors to observe the cascade emissions of these gamma rays. A coincidence circuit which employed simultaneous energy measurements and a three dimensional data storage technique was used. Several new gamma rays were discovered and identified and on the basis of the measurements a new, revised decay scheme is presented for the excited states of $^{233}$Pa. Conversely a search for gamma-ray transitions from a proposed first excited state at 6.7 keV and between the energy levels at 94.8 keV and 86.6 keV yielded no positive evidence to support their existence. This search was carried out using a very high resolution Si(Li) detector. (auth)

**29888** DEEP INELASTIC TRANSFER REACTIONS AND THE FORMATION OF A DOUBLE NUCLEAR SYSTEM. Volkov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). pp 253-273 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

Experimental data on multi-nucleon transfer reactions, obtained mainly by bombarding $^{232}$Th with the $^{16}$O, $^{22}$Ne and $^{40}$Ar ions with an energy of 7 to 9 MeV/nucleon are discussed. The energy spectra of light reaction products and isotopic production cross sections show some features which are difficult to interpret in the framework of conventional direct processes. The concept of a double nuclear system is proposed, which allows one to explain these features easily. (auth)

**29889** ANALYSIS OF ANGULAR DISTRIBUTION OF ELASTICALLY SCATTERED NEUTRONS ON $^{235}$U. Sukhovitskii, E. Sh.; Benderskii, A. R.; Kon'shin, V. A. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 23-31(1975). (In Russian).

Analysis of available experimental data on neutron scattering angular distribution for $U^{235}$ in the energy region 0,5–14 Mev is carried out using expansions of terms containing Bessel functions and Legendre polynomials. It is shown that Bessel function expansions have some advantages in comparison with Legendre expansions, namely, avoiding negative excursions of the calculated curves. Fewer terms should be required to fit the data, with no necessity to have the experimental data 0 and 180°. (1 table, 1 figure) (auth)

**29890** HALF-LIFE OF $^{254}$Es. Ahmad, I.; Unik, J. P. (Argonne National Lab., IL). J. Inorg. Nucl. Chem.; 37: No. 9, 1851-1853(Sep 1975).

The half-life of the $^{254}$Es ground state was measured by following the decay of the daughter $^{250}$Bk (3.1 Hr) gamma-rays in radioactive equilibrium with $^{254}$Es. An isotopically enriched $^{254}$Es sample was used and the gamma-rays were counted with a high resolution 25 cm$^3$ Ge(Li) spectrometer. $^{137}$Cs activity, fixed to the $^{254}$Es sample, was used as an internal calibration source to correct for the variations in the source-to-detector geometry. The decay of the gamma-ray spectrum was followed for 2 yr. A least-squares fit to the areas of the 989.0 and (1028.6 + 1031.8) keV photopeaks gave a half-life of 275.7 ± 0.5d for $^{254}$Es. (auth)

**29891** FISSION OF $^{232}$Th, $^{238}$U AND $^{235}$U INDUCED BY NEGATIVE MUONS. Chultem, D.; Cojocaru, V.; Gansorig, D.; Chwan, K. S.; Krogulski, T.; Kuznetsov, V. D.; Ortlepp, H. G.; Polikanov, S. M.; Sabirov, B. M.; Schmidt, U. (Joint Inst. for Nuclear Research, Dubna (USSR)). Nucl. Phys., A; 247: No. 3, 452-472 (11 Aug 1975).

The absolute yields of prompt and delayed fission induced by negative muons in $^{232}$Th, $^{238}$U and $^{235}$U have been measured. The delayed fission yields are much lower than could be predicted from $\Gamma_n/\Gamma_f$ systematics for 15-20 MeV nuclear excitation. The systematics of prompt fission yields are compared with recently obtained photofission data. It is suggested that prompt fission can be used for investigating the channel structure of the fission barrier. (auth)

**29892** SUBSTRUCTURE EFFECTS IN THE FISSION OF FERMIUM. Goennenwein, G. (Teubingen Univ. (F. R. Germany). Physikalisches Inst.); Schultheis, H.; Schultheis, R.; Wildermuth, K. (Tuebingen Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Phys. Lett., B; 57: No. 4, 313-316(21 Jul 1975).

The fission of Fm and neighboring nuclei is studied on the basis of cluster representations. A comparison of the relevant two-cluster terms shows in all fermium isotopes that symmetric fission mode is enhanced by (Z = 50)-substructures whereas it is a pure liquid-drop effect in all lighter actinides. (auth)

# Nuclear Theory

*Refer also to abstracts 29338, 29401, 29517, 29585, 29627, 29645, 29654, and 29859.*

**29893** (AEC-tr-7533/5) NUKLEONIKA. Translation of Nukleonika; 19: No. 5, 387-504(1974). 116p. (TT-74-54003/5). Dep. NTIS $5.45.

The journal Nukleonika is regularly rendered into English for the U.S. Government. This report presents volume 19, number 5. The following papers are included: direct reactions, unitarity, and Hauser–Feshbach theory; simple configurations in the continuum; semidirect capture of neutrons; delayed proton emission and nuclear structure studies; effective matrix elements in deformed nuclei; and on effective interactions and effective charges in the shell model. These papers were cited in NSA upon their original appearance, with the following abstract numbers: 30: 22906, 30: 22907, 30: 22822, 30: 22749, 30: 22908, and 30: 22909. (RWR)

**29894** (AEC-tr-7533/7-8) NUKLEONIKA. Translation of Nukleonika; 19: No. 7-8, 607-766(1974). 149p. (TT-74-54003/7-8). Dep. NTIS $5.45.

The journal Nukleonika is regularly published in an English version for the U.S. Government. This report presents volume 19, number 7-8, pages 607-766, for 1974. The papers were cited in NSA (vol. 31, no. 5, March 15, 1975) at their original publication with the following abstract numbers: 12888, 12992, 12993, 12953, 12912, 12802, 12825, 12995, 12803, 12889, 12997, 12996, 12826, 12470, and 12471. (RWR)

**29895** (BNL-tr-598) GENERALIZED PORTER–THOMAS DISTRIBUTION FOR RESONANCE WIDTHS. Luk'yanov, A. A.; Shaker, M. O. Translated by S. J. Amoretty from Yadern. Fiz.; 10: No. 4, 790-793(1969). 10p. Dep. NTIS $4.00.

Distribution of the resonance widths for many-channel reactions is obtained in the framework of the Porter–Thomas statistical method for arbitrary fractional contributions of various channels to the averaged widths. Experimental distribution of the fission widths of the $^{235}U$ neutron resonances is analyzed. For both of the two possible values of the total angular momentum the following quantities are estimated: averaged fission widths, fission channel number, and their fractional contribution with account of a possible (n, γf) process. (auth)

**29896** (CONF-730750–, pp F1-F25) DIRECT REACTIONS LEADING TO PARTICLE UNSTABLE STATES. Hartmann, K. M. (Univ. of Cape Town). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In eighth annual seminar on theoretical physics.

The appropriate bound state wave functions appearing in the usual DWBA transition amplitudes for stripping reactions and inelastic scattering are replaced by the wave functions for a particle unstable nucleus. The continuum shell-model theory is used to obtain this wave function. The bound and resonant states of the shell-model Hamiltonian are treated on equal footing. The transition amplitudes are a sum of a background term, corresponding to direct breakup or knockout, and a resonant term, describing the formation and decay of a long lived intermediate state. A relation for the spectroscopic factor as a ratio of the total and partial widths is derived and its applicability and validity are discussed. Reactions to which the theory should be especially applicable are mentioned. (auth)

**29897** (INT-62/PS) CONSIDERATIONS ON THE MOESSBAUER LINE-WIDTH IN SCATTERING EXPERIMENTS. Ruebenbauer, K.; Zurek, W. (Institute of Physics and Nuclear Techniques, Krakow (Poland)). 1975. 30p. Dep. NTIS (US Sales Only) $4.50.

An analysis is given of the Moessbauer line shape after scattering by a resonance, isotropic target. It is shown that linewidth depends on the scattering geometry and under special circumstances may be smaller than natural line-width. Linewidth may be reduced under these special conditions up to 0.643 natural line-width in a single scattering process. (auth)

**29898** (JAERI-1231, pp 134-136) $3/2^-$ STATES IN THE SHELL NUCLEI. Oda, T. (Tokyo Inst. of Tech.). 13 Dec 1972.

From symposium on nuclear reaction and nuclear structure; Tokai, Ibaraki, Japan (13 Dec 1972).

In proceedings of a symposium on nuclear reaction and nuclear structure. (Japan Atomic Energy Research Inst., Tokyo).

The results of a shell model calculation based on the $(f_{\frac{7}{2}})^n$ pure configuration are discussed. Configuration mixing calculations, in which one particle excitation to the $p_{\frac{3}{2}}$ shell, are done for the Sc isotopes, and a tendency of the states is well reproduced. (auth)

**29899** (JINR-R-4-8101) NEW METHOD FOR SEPARATING THE CENTRE OF MASS MOTION OF CLUSTERS IN NUCLEI. Kadmenskii, S. G.; Stratan, G.; Furman, V. I.; Kholan, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 22p. (In Russian). INIS.

A method was developed for defining the movement of the center of mass of a cluster consisting of an arbitrary number of particles moving in a Woods–Saxon potential. The method is accurate for arbitrary momenta of relative movement and any ratio between particle masses. (tr-auth)

**29900** (JINR-R-4-8206) APPLICATION OF A MODEL FOR THE DESCRIPTION OF THE STRUCTURE OF HIGHLY EXCITED STATES OF DEFORMED NUCLEI TO THE CASE OF A WAVE FUNCTION CONTAINING A THREE-PHONON COMPONENT. Malov, L. A.; Nesterenko, V. O. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 18p. (In Russian). INIS.

Within the framework of a semimicroscopic model for describing highly activated states of deformed nuclei, an approximate analytical solution was found for energy and wave functions of highly activated nonrotating states of odd deformed nuclei. The wave function includes the component of quasiparticles of σ + 3 proton. (tr-auth)

**29901** (JINR-E4-8816) CLUSTER MODEL AND THE SADDLE POINT METHOD. Lapushkin, S. S.; Moshchinskii, B. V.; Fedyanin, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 19p. Dep. NTIS (US Sales Only) $4.00.

Some asymptotic estimations for free energies are calculated with the help of the Cluster Hamiltonians. A possibility of the extension of the class of the approximative Hamiltonians for Cluster Model has been discussed. (auth)

**29902** COLLECTIVE DESCRIPTION OF MAGNETIC PROPERTIES OF EVEN–EVEN NUCLEI. Maruhn-Rezwani, V.; Greiner, W. (Frankfurt Univ. (F. R. Germany). Inst. fuer Theoretische Physik); Maruhn, J. A. (Oak Ridge National Lab., Tenn. (USA)). Phys. Lett., B; 57: No. 2, 109-112(23 Jun 1975).

A general treatment of magnetic properties of even-even nuclei in the framework of the collective model is proposed in a perturbation-theoretic approximation. (auth)

**29903** SPECTRUM OF ELECTRON–NUCLEAR γ-TRANSITIONS IN ATOMIC NUCLEI. Ivanov, L. N.; Letokhov, V. S. (Inst. of Spectroscopy, Moscow). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1748-1756(May 1975). (In Russian).

The electronic state of an atom may change after emission or absorption of γ quanta by the atomic nucleus due to recoil of the nucleus and inertia of the electronic shell. This leads to the appearance of electronic satellites in the nuclear γ-radiation spectrum. The positions and intensities of the electron-nuclear transition lines and means of their experimental observation are proposed. The shape of the Doppler contour is analyzed in the case of overlapping of the satellites and major line due to Doppler broadening. It is shown that on resonant excitation of the atom by coherent laser radiation the satellites are manifest as narrow resonances in the Doppler contour. (auth)

**29904** ROTATIONAL INVARIANCE AND EFFECTIVE CHARGES FOR E2 TRANSITIONS WITH ΔK = 1 IN ODD-MASS NUCLEI. Baznat, M. I.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 4, 708-719(Apr 1975). (In Russian).

A method of self-consistent restoration of rotational invariance of the model Hamiltonian is proposed for an arbitrary axial symmetrical average field. The method is used to consider the dynamical effective charges for E2 transitions between single-particle states with ΔK = 1. (1 figure, 2 tables) (auth)

**29905** STUDY OF THE A = 6 NUCLEI IN THE BASIS OF THE UNITARY SCHEME MODEL. Doma, S. B.; Kopaleishvili, T. I.; Machabeli, I. Z. (Tbilissi State Univ., USSR). Yadern. Fiz.; 21: No. 4, 720-729(Apr 1975). (In Russian).

The binding energy, the structure of the wave function, the excitation spectrum, the magnetic dipole moment, the ft value for the allowed $\beta^-$ transition, the partial and integral cross sections of the dipole electric transition accompanying the γ absorbtion for A = 6 nuclei are studied. The nuclear wave function is being expanded in the basis of the unitary scheme model. Two configurations are entirely taken into account in the expansion: the ground configuration with N = 2 and the next one with N = 4 for the positive parity levels and the configuration with N = 3 for the negative parity levels. Two nonsingular realistic potentials are used in the calculations. It is shown that (1) in the unitary scheme model one can satisfactorily describe the data on some properties of the $^6Li$ nucleus; (2) taking into account the higher configurations considerably improves the agreement between the

theory and the experimental data; (3) the most proper potential of the NN interaction at small distances gives the best fits to the calculated characteristics of the $^{6}$Li nucleus. (2 figures, 1 table) (auth)

**29906** IDENTIFICATION OF STATES OF NUCLEAR CONTINUOUS SPECTRUM. Titarenko, N. N. Yadern. Fiz.; 21: No. 4, 730-736(Apr 1975). (In Russian).

The electron energy loss spectra and form factors of a number of states of the carbon multipole resonance are treated in the framework of the channel strong coupling method which gives the most consistent way to consider the nature of quasistationary levels. The calculations are compared with recent data. It is discussed how to extract correctly the spectroscopic information from the data. The coincidence method is proposed for an unambigious identification of states of nuclear continuous spectra. (1 table, 5 figures) (auth)

**29907** UPPER VARIATIONAL ESTIMATES OF INTERACTION ENERGY OF NUCLEONS INSIDE ATOMIC NUCLEUS. Savchenko, O. Ya. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 21: No. 4, 737-743(Apr 1975). (In Russian).

The upper bound of the mean interaction energy of nucleons in a nucleus is determined as a difference between the own energy of the nucleus and a conditional minimum of the kinetic energy of such a system where a number of mean quantities coincide with the mean quantities of the atomic nucleus. The more nuclear parameters used in the calculations, the better the result will be, but the calculations become more complicated. One (the mean square radius, the Coulomb energy) or two (the mean square radius and the density half-height radius) nuclear parameters were used in the estimates. Use of such estimates of the density of nucleons inside a nucleus leads to the equations of the simplified one-particle model. That means that in the framework of that model the kinetic energy is lower and the interaction energy of nucleons is higher than the real values. The results do not depend on the form of the nucleon-nucleon potential. (1 figure) (auth)

**29908** REAL PART OF THE OPTICAL POTENTIAL FOR COMPOSITE PARTICLES. Perkin, D. G.; Kobos, A. M.; Rook, J. R. (Oxford Univ. (UK). Nuclear Physics Lab.). Nucl. Phys., A.; 245: No. 2, 343-364(30 Jun 1975).

The optical potential for a composite particle is most simply approximated by the sum of the optical potentials of the constituent nucleons. Restricting oneself to the real parts of the potentials this model is used as a first approximation in a calculation of the potentials for d, $^{3}$He, $\alpha$ and $^{12}$C. Corrections are added for (i) the energy dependence of the nucleon potentials, (ii) three-body terms, (iii) the Pauli principle. All corrections can be important and that for the Pauli principle can be very large. A good explanation of the following phenomena is obtained: (a) the deuteron potential is nearly the sum of the neutron and proton potentials, (b) the potential for $^{3}$He is about 20% less than the sum of the potentials of the nucleons in the $^{3}$He projectile, (c) the volume integral of the potential for $^{3}$He falls at both high and low energies in the energy range 20-100 MeV, (d) shallow potentials with large radii are found for low energy (30 MeV) scattering of $\alpha$-particles, (e) deeper potentials are found for higher energy $\alpha$-particle scattering. Shallow potentials are predicted for $^{12}$C scattering from light targets but deeper potentials for heavier targets. (auth)

**29909** BAND HYBRIDIZATION IN ROTATIONAL MOTION. Broglia, R. A. (State Univ. of New York, Stony Brook (USA)); Molinari, A.; Pollarolo, G. (Turin Univ. Italy). Istituto di Fisica); Regge, T. (Institute for Advanced Study, Princeton, N. J. (USA)). Phys. Lett., B.; 57: No. 2, 113-116(23 Jun 1975).

The back-bending behavior of the moment of inertia as a function of the square of the angular velocity, for the ground-, and $\beta$-rotational trajectories in $^{154}_{66}Dy_{88}$, is described in terms of band hybridization. (auth)

**29910** CONSISTENCY TESTS IN QRPA CALCULATIONS. Peltier, S. M. (La Plata Univ. Nacional (Argentina)); Plastino, A. (International Centre for Theoretical Physics, Trieste (Italy)); Hernandez, E. S. (Consejo Nacional de Investigaciones Cientificas y Tecnicas, Buenos Aires (Argentina)). Phys. Lett., B.; 57: No. 2, 127-129(23 Jun 1975).

An illustrative example clearly shows that if meaningful conclusions are to be drawn from QRPA calculations, a consistency test should always be performed. (auth)

**29911** SPECTRAL AVERAGING FOR SINGLE-NUCLEON-TRANSFER SUM RULES. Draayer, J. P.; French, J. B.; Prasad, M.; Potbhare, V. (Rochester Univ., N. Y. (USA). Dept. of Physics and Astronomy); Wong, S. S. M. (Toronto Univ., Ontario (Canada). Dept. of Physics). Phys. Lett., B.; 57: No. 2, 130-134(23 Jun 1975).

Spectral averaging methods are used to calculate, directly in terms of the Hamiltonian matrix elements, the quantities determined by the non-energy-weighted and linear-energy-weighted sum rules for single-nucleon addition and removal. Occupancies and strength centroids, and their isospin decomposition, are given throughout the spectrum for some ds-shell cases. (auth)

**29912** SIMPLE INTERPRETATION OF ANOMALOUS ANGULAR DISTRIBUTIONS IN HEAVY-ION INDUCED TWO-STEP TRANSFER REACTIONS. Udagawa, T.; Tamura, T. (Texas Univ., Austin (USA). Center for Nuclear Studies). Phys. Lett., B.; 57: No. 2, 135-138(23 Jun 1975).

A simple and transparent explanation is given of why CCBA calculations can fit simultaneously the normal as well as the anomalous angular distributions in transfer reactions between heavy ions. (auth)

**29913** CONSTANT WIDTH APPROXIMATIONS FOR LARGE SPECTROSCOPIC CALCULATIONS. Lougheed, G. D.; Wong, S. S. M. (Toronto Univ., Ontario (Canada). Dept. of Physics). Nucl. Phys., A.; 246: No. 1, 29-42(14 Jul 1975).

The widths, which along with the centroids define the strength distributions for the subspaces of a given (mJT) space, are found to be clustered within a narrow range of values. Approximations to the fixed-JT averaging spectral distribution method based on this factor are suggested and their accuracies discussed. Using these approximations, one can now perform nuclear structure calculations in a large model space with good accuracy and at a relatively low cost. (auth)

**29914** NUCLEAR EXCITATION BY ELECTRONS AND POSITRONS. Nascimento, I. C.; Wolynec, E. (Sao Paulo Univ. (Brazil). Instituto de Fisica); Onley, D. S. (Ohio Univ., Athens (USA)). Nucl. Phys., A.; 246: No. 1, 210-220(14 Jul 1975).

Existing measurements of the ratio $\sigma^{-}/\sigma^{+}$, the nuclear excitation cross sections produced by electrons and positrons, are compared with the results of distorted wave calculations. The behavior as a function of atomic number Z and electron energy $E_1$ is shown to be principally due to Coulomb distortion. The $\sigma^{-}/\sigma^{+}$, displays no clear structure corresponding to resonances in the photoabsorption cross section, except that it should be quite sensitive to the presence of quadrupole strength. (auth)

**29915** CALCULATION OF THE COULOMB TERM IN INELASTIC SCATTERING. Mackintosh, R. S. (Oxford Univ. (UK). Nuclear Physics Lab.). Nucl. Phys., A.; 245: No. 2, 255-261(30 Jun 1975).

The customary deformed-hard-sphere method of calculating the Coulomb excitation term in inelastic scattering of $\alpha$-particles from deformed nuclei is shown to be inadequate. An exact double folding calculation which eliminates the ambiguity in choice of Coulomb radius results in a change in the extracted $\beta_2$ for $^{154}$Sm from 0.225 to 0.26. This work has possible implications for a wide range of heavy ion scattering which deserve exploration. (auth)

**29916** BINDING ENERGY AND WAVE FUNCTION OF THE alpha-PARTICLE GROUND STATE. Obersnel, B. Manhattan, KS; Kansas State University (1974). 194p. University Microfilms Order No. 75-14,375.

Thesis (Ph. D.).

The binding energy problem for the alpha particle is considered using an orthonormal classification of the ground state wave functions and an interaction potential represented by a superposition of the two-body Hamada–Johnston potentials for the six nucleon pairs. Matrices for energy terms of the alpha particle and a matrix for the ground-state wave function are determined in a 32-dimensional spin–isospin space. The 6-dimensional phase-space integrals are solved by the Monte Carlo method. In first approximation, the wave function is assumed to consist of a principal S-state wave function and one of five D-state wave functions. The radial parts of the wave functions are assumed Gaussian. The boundary condition on the wave function at the hard core radius, r/sub c/, is satisfied by introduction of a continuous correlation function which is zero inside the hard core, quadratic in the "adjustment" region, (r/sub c/, r/sub c/ + d), characterized by a "healing" distance d and 1 for an interparticle distance beyond r/sub c/ + d. For the model, in which we neglect the effect of the spin–orbit coupling term and the quadratic spin–orbit term in the energy balance and in which we do not account for the repulsive Coulomb interaction, calculations yield a minimum internal energy for the alpha particle of (31,68 ± 2,69) MeV. After a modification of the Hamada–Johnston potential, by reducing the critical radius,

r/sub c/, to 0.385 fm (slightly more than 20 percent lower value than the one suggested by Hamada and Johnston), the minimum total energy for the chosen model is (-25.09 +- 3.00) MeV. This result can be compared with the well-known experimental value of 28.296 MeV for the alpha particle binding energy. (Diss. Abstr. Int., B.)

**29917** ANGULAR MOMENTUM DEPENDENCE OF THE DISTRIBUTION OF SHELL MODEL EIGENENERGIES. Yen, M. K. New Haven; Yale University (1974). 209p. University Microfilms Order No. 75-15,402.

Thesis (Ph. D.).

In the conventional shell model calculation the many-particle energy matrices are constructed and diagonalized for definite angular momentum and parity. However the resulting set of eigenvalues possess a near normal behavior and hence a simple statistical description is possible. Usually one needs only about four parameters to capture the average level densities if the size of the set is not too small. The parameters are essentially moments of the distribution. But the difficulty lies in the yet unsolved problem of calculating moments in the fixed angular momentum subspace. We have derived a formula to approximate the angular momentum projection dependence of any operator averaged in a shell model basis. This approximate formula which is a truncated series in Hermite polynomials has been proved very good numerically and justified analytically for large systems. Applying this formula to seven physical cases we have found that the fixed angular momentum projection energy centroid, width and higher central moments can be obtained accurately provided for even-even nuclei the even and odd angular momentum projections are treated separately. Using this information one can construct the energy distribution for fixed angular momentum projection assuming normal behavior. Then the fixed angular momentum level densities are deduced and spectra are extracted. Results are in reasonably good agreement with the exact values although not as good as those obtained using exact fixed angular momentum moments. (Diss. Abstr. Int., B)

**29918** OPERATOR AVERAGES AND APPLICATIONS IN LIGHT NUCLEI. Ayik, S. New Haven; Yale University (1974). 195p. University Microfilms Order No. 75-11,275.

Thesis (Ph. D.).

In order to calculate scalar averages of the product of any number of operators, over a finite number of many particle states, a diagrammatic method is developed. This method is generalized to configuration averages and to fixed isospin averages, and it is found that these averages follow trivially from the results of scalar averages. The scalar and configuration averages of the product of three and four two-body operators are derived. Recent theoretical research has shown that shell model level densities are near normal. Hence the level densities for light nuclei are assumed Gaussian and the centroid and widths of these shell model level densities with fixed angular momentum projection and isospin are calculated and tabulated for many light nuclei using these averaging techniques and an approximate formalism for the angular momentum dependence. The core ($^{16}$O) is assumed inert; the valence nucleons are assumed to move in an average field, but are confined to the (1s,0d,0f/sub 7/2/) orbitals, and interact via realistic effective two nucleon interactions. Both the energy and angular momentum dependence of these Gaussian level densities are compared, near the proton threshold, to those of the Fermi level densities used in the compound heavy ion reactions. The general conclusion is that the Fermi level density rise too rapidly with energy and underestimate the level densities of higher angular momentum states. The shell model level densities are used to extract ground state energies and low excitation spectra for light nuclei and these are compared to empirical values. Predicted Yrast lines agree quite well with recent experimental data on high angular momenta states in $^{23}$Na and $^{23}$Mg. (Diss. Abstr. Int., B)

**29919** ENSEMBLE OF RANDOM HAMILTONIANS WITH LINEAR RESTRICTIONS AMONG MATRIX ELEMENTS. Mello, P. A. (Instituto Politecnico Nacional, Mexico City). Lett. Nuovo Cim.; 13: No. 16, 623-628(16 Aug 1975).

An analytical discussion is presented of the problem of statistical regularities in nuclear spectra via the two-body random Hamiltonian ensemble. Matrix elements are obtained and a simple case is illustrated. (3 figures) (SDF)

**29920** CALCULATION OF RESONANCE PARAMETERS IN THE CONTINUUM SHELL MODEL. Barz, H. W.: Rotter, I. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nukleonika; 20: No. 4, 413-422(1975).

A method is given for the calculation of resonance energies and widths in the continuum shell model. The values are almost independent on the direct reaction part. They are compared with the resonance parameters calculated in the shell model. Numerical results are given. (auth)

**29921** ACAUSALITY OF THE KISSLINGER POTENTIAL. Cannata, F. (Univ., Bologna). Lett. Nuovo Cim.; 13: No. 16, 620-622(16 Aug 1975).

Certain pathologies arising from the Kisslinger model of low energy pion-nucleus scattering are discussed. In particular, the causal description of pion propagation inside nuclear matter and the virtual pion production in infinite nuclear matter responsible for the induced pseudoscalar coupling in muon capture are considered. (SDF)

**29922** EXAMPLE IN POTENTIAL SCATTERING ILLUSTRATING THE BREAKDOWN OF ASYMPTOTIC COMPLETENESS. Pearson, D. B. (Geneva Univ. (Switzerland). Inst. de Physique Theorique). Commun. Math. Phys.; 40: No. 2, 125-146(Feb 1975).

An example is given of a local spherically symmetric short range potential, such that the wave operators for scattering of a single particle by the potential are not complete. States exist which are asymptotically free at t = -infinity, but having a non zero probability of absorption into the origin at t = +infinity. (auth)

**29923** ASPECTS OF TRANSFER REACTIONS BETWEEN HEAVY IONS. Goldfarb, L. J. B. (Univ. of Manchester, Eng.). Nukleonika; 20: No. 4, 345-373(1975).

A summary is given of improvements in the theoretical treatment of transfers of nucleons between heavy ions. Concentration is given to the energy regions that straddle the Coulomb barrier where much of the experiments have been performed. Some discussion is given to quantum diffraction aspects of elastic scattering and to their implications on transfer reactions. (18 figures, 46 references) (auth)

**29924** LOW ENERGY THEOREMS FOR NUCLEI. Christillin, P.; Rosa-Clot, M. (Scuola Normale Superiore, Pisa, Italy). Nuovo Cim., 28A: No. 1, 29-41(1 Jul 1975).

A generalization of low-energy theorems is given to obtain the Compton-scattering amplitude on nuclei up to energies smaller than the excitation of nucleons. By means of this technique the presence of seagull terms coming from exchange forces is predicted, and the consistency of their contribution is demonstrated in the framework of subtracted dispersion relations. (1 table, 1 figure) (auth)

**29925** SHELL ENERGY IN FISSION AND ITS RELATION TO THE CLUSTER STRUCTURE OF NUCLEI. Schultheis, H.; Schultheis, R.; Wildermuth, K. (Univ., Tuebingen, Ger.). Nukleonika; 20: No. 4, 423-427(1975).

The shell energy in fission is calculated using cluster representations. The results for $^{236}$U show that the ground state and the second minimum are due to the formation of doubly-magic clusters, while the barriers are due to their breakup. (2 figures) (auth)

**29926** TWO CENTER OSCILLATOR POTENTIAL WITH FINITE DEPTH. Ong, P. T.: Scheid, W. (Frankfurt Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Z. Naturforsch., A; 30: No. 4, 406-412(Apr 1975).

4 figs.; 15 refs.

It is suggested to diagonalize the Hamilton operator of a two or more center shell model in terms of oscillator functions concentrated around the individual centers. The method is applied to the case of a two center oscillator with finite depth. (auth)

**29927** RELATION BETWEEN THE STRUTINSKY METHOD AND THE STATISTICAL APPROACH FOR SHELL CORRECTION ENERGIES. Bersia, C.; Bottino, A. (Univ., Turin). Nuovo Cim., 28A: No. 1, 51-61(1 Jul 1975).

Generalizing a result of Bhaduri and Das Gupta, it is shown that the Strutinsky averaging method and the statistical method for evaluating the shell corrections to nuclear binding energies are analytically equivalent for any Strutinsky smoothing function. (auth)

**29928** NUCLEAR JOSEPHSON EFFECT. Hara, K. (Technische Universitaet, Munich/Garching, Ger.). Nukleonika; 20: No. 4, 375-388(1975).

The analogy between the multiple Coulomb excitation of deformed nuclei and the multiple pair-transfer (nuclear Josephson effect) between two superconducting nuclei is pointed out. The qualitative feature of the phenomenon is discussed in terms of a simple solvable model. It is also shown that the Coulomb excitation screens the pair-transfer. (8 figures) (auth)

**29929** SHELL STRUCTURE IN DEFORMED NUCLEI. Sheline, R. K. (Florida State Univ., Tallahassee); Ragnarsson, I. Contract AT(40-1)2434. Nukleonika; 20: No. 4, 389-411(1975).

From a plot of the eigenvalues for the harmonic oscillator without l . s- or $l^2$-terms, shell structure is observed for a wide variety

of different prolate, oblate and spherical structures in the forms of gaps in the level structure. These gaps occur at a variety of different nucleon "magic numbers" which vary depending on the deformation. As in the case for spherical nuclei, these "magic numbers" are subject to small increases due to spin-orbit and other correction terms. Experimental evidence for the special stability caused by this shell structure is presented both for light and heavier nuclei. For the most part this experimental evidence is spectroscopic in nature. Usually it represents the observation of a ground state or low lying band with a value of Dirac constant$^2$/2J which is anomalously small. A plot of the 2+ energies of these anomalous rotational bands over the entire nuclear periodic table shows that these energies can be correlated with the appropriate shapes and shell structures. Attempts to calculate the corresponding potential energy surfaces using the Strutinsky shell correction method are also described and a brief presentation of an oblate superheavy nucleus (Z equals 124, N equals 176) is given. (3 tables, 18 figures) (auth)

**29930** DO LOWEST-ORDER APPROXIMATIONS ADEQUATELY DESCRIBE NUCLEAR MATTER. Pandharipande, V. R.; Wiringa, R. B. (Illinois Univ., Urbana (USA)); Day, B. D. (Argonne National Lab., Ill. (USA)). Phys. Lett., B; 57: No. 3, 205-209(7 Jul 1975).

The energies of simple many-body systems are calculated with the lowest-order Brueckner theory and with the lowest-order constrained variational method, and the results are compared with accurate variational upper bounds. The comparison suggests that the lowest-order methods can have errors of the dispersion correction (approximately 12 MeV in nuclear matter), and hence are not accurate enough to study nuclear matter. (auth)

**29931** STATISTICAL EMISSION OF LARGE FRAGMENTS: A GENERAL THEORETICAL APPROACH. Moretto, L. G. (California Univ., Berkeley (USA). Dept. of Chemistry). Nucl. Phys., A; 247: No. 2, 211-230(4 Aug 1975).

A theory for the statistical emission of large fragments is developed. In analogy with the fission saddle point, a ridge line in the potential energy surface is defined which controls the decay width of the system into any two given fragments. The normal modes at the ridge are separated into three classes: decay modes, amplifying modes, and non-amplifying modes. Amplifying modes are those whose thermal fluctuations are amplified and lead to a broadening of the kinetic energy distribution. Analytical expressions for the kinetic energy distributions are developed for various combinations of amplifying and non-amplifying modes. The limit for large amplifications is a Gaussian kinetic energy distribution. The limit for no amplification is a Maxwellian-like distribution. Thus the formalism comprehends the fission decay on one hand and the neutron evaporation on the other. The angular distributions are evaluated in terms of the ridge-line principal moments of inertia. A general analytical expression has been derived which predicts, correctly in both limits, the angular distributions of the evaporated neutrons and of the fission fragments. (auth)

**29932** FACTORIZED KNOWLEDGE FROM FACTORIZED POLARIZATION EXPERIMENTS. Moravcsik, M. J. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science). Phys. Lett., B; 57: No. 3, 213-216(7 Jul 1975).

A general analysis is presented which yields a simple and economical picture of the information obtained about the reaction amplitudes from an incomplete set of polarization experiments. Spinwise inclusive ("spin-clusive") reactions can thus furnish "spinclusive" information about the amplitudes. The analysis is used to derive a method to determine the spin of a particle in a reaction without ever measuring anything about that particle. (auth)

**29933** POSITIVE AND NEGATIVE DEFLECTION-ANGLE COULOMB SCATTERING. Fuller, R. C. (Brookhaven National Lab., Upton, N. Y. (USA)). Phys. Lett., B; 57: No. 3, 217-219 (7 Jul 1975).

The decomposition of the Rutherford amplitude into positive and negative deflection-angle contributions shows how Fraunhofer diffraction for charged-particle scattering is moved away from forward angles. (auth)

**29934** EXTENSION OF THE THEORY OF FINITE FERMI SYSTEMS TO THE PARTICLE-CORE COUPLING MODEL. Zamick, L. (Rutgers-the State Univ., New Brunswick, N. J. (USA). Dept. of Physics); Klemt, V. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik); Speth, J. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). Nucl. Phys., A; 245: No. 3, 365-375(7 Jul 1975).

The theory of finite Fermi systems is extended to the particle-core coupling model. As an example electric and magnetic moments and transition probabilities of $^{205}$Tl were calculated. A detailed discussion of $^{205}$Tl and $^{207}$Tl is given. The theoretical results are in good agreement with experiment. (auth)

**29935** VARIATIONAL PRINCIPLE WITH A n-PAIR WAVE FUNCTION. Lorazo, B. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). Nucl. Phys., A; 245: No. 3, 397-410(7 Jul 1975).

New variational equations for a n-pair wave function are presented. They are as simple as the gap equations, can be solved without any approximation and are free of the trivial solution even in the limit of weak residual interactions. (auth)

**29936** BINDING ENERGY OF NUCLEAR MATTER FROM A PHYSICAL PARTICLE SPECTRUM. Jeukenne, J. P.; Lejeune, A.; Mahaux, C. (Liege Univ. (Belgium). Inst. de Physique Nucleaire). Nucl. Phys., A; 245: No. 3, 411-428(7 Jul 1975).

A non-vanishing potential energy is used for the intermediate particle states in the Bethe-Brueckner expansion for the binding energy of nuclear matter. This potential energy is identified with the depth of the optical-model potential. It turns out that, in addition to this physical meaning, the potential spectrum shares the properties previously required by several authors: it presents no gap at the Fermi momentum $k_F$; it is small and possesses the proper energy and density dependence at high momenta. Detailed calculations are performed with Reid's hard-core interaction. The two-hole contribution $B_2$ is found to be -12.2 MeV at the saturation momentum $k_F = 1.30$ fm$^{-1}$. A crude estimate of the three- and four-hole line contributions gives B = -15.60 MeV, $k_F = 1.34$ fm$^{-1}$. These results lie closer to the empirical values than those obtained in the conventional calculations where the potential energy in particle states is set to zero. In the latter case one finds, in the two-hole line approximation, $B_2 = -9.05$ MeV, $k_F = 1.30$ fm$^{-1}$; by estimating the three- and four-hole line contribution, one obtains B = -9.70 MeV, $k_F = 1.36$ fm$^{-1}$. (auth)

**29937** MICROSCOPICALLY SUBSTANTIATED LOCAL OPTICAL POTENTIALS FOR SCATTERING OF LIGHT NUCLEI. Kukulin, V. I.; Neudatchin, V. G.; Smirnov, Yu. F. (Moskovskij Gosudarstvennyj Univ. (USSR). Inst. Yadernoj Fiziki). Nucl. Phys., A; 245: No. 3, 429-443(7 Jul 1975).

A potential approach to the scattering of light nuclei is analyzed in detail. It is shown that the deep optical potentials introduced earlier for the scattering of light clusters are essentially phase-equivalent local potentials for the tedious exchange kernels of the resonating-group method and lead, practically, to the same wave functions. It is demonstrated that these deep potentials involve the shell-model states of a system, forbidden by the Pauli principle, as their own bound states. Requirements for optical potentials and for optical wave functions of light nuclei following from the properties of these forbidden states have been formulated. The supermultiplet and even-odd l-splitting of optical potentials is investigated. The concrete systems $\alpha-\alpha$, $\alpha-t$, $t-{}^3He$ and $\alpha-d$ (optical potentials, etc.) are investigated. The optical potentials for the scattering of heavy ions such as $^{16}O-^{16}O$ and the relationship between the deep optical potentials and the commonly used shallow phenomenological potentials containing the repulsive core are also briefly discussed. (auth)

**29938** NEUTRON MATTER IN BRUECKNER THEORY WITH THE REID HARD-CORE AND MONGAN POTENTIALS. Haensel, P. (Warsaw Univ. (Poland). Instytut Fizyki Teoretycznej). Nucl. Phys., A; 245: No. 3, 528-540(7 Jul 1975).

The energy per particle in pure neutron matter is calculated in lowest-order Brueckner theory with the Reid hard-core potential and the Mongan nonlocal separable potential. The integral equation method of Brueckner and Gammel is used for the calculation of the K-matrix for the Reid hard-core potential. The defect parameter $\kappa$ is less than 0.2 for the Reid hard-core potential at $\rho = 0.5$ fm$^{-3}$, and stays smaller than 0.1 for the Mongan potential even at $\rho = 1.0$ fm$^{-3}$. The results are discussed and compared with those obtained for the Reid soft-core potential. (auth)

**29939** ANGULAR DISTRIBUTION OF NUCLEONS IN NUCLEON-INDUCED PREEQUILIBRIUM REACTIONS. Mantzouranis, G.; Agassi, D.; Weidenmueller, H. A. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Phys. Lett., B; 57: No. 3, 220-222(7 Jul 1975).

In reactions induced by light projectiles ($A \lesssim 4$) on medium-weight and heavy nuclei with bombarding energies of several tens of MeV, substantial deviations from the statistical model are observed. A model is presented which leads to a generalized master equation from which both angular distributions and spectra of preequilibrium nucleons can be successfully calculated. Implications and limitations of this model are discussed. (auth)

**29940** TRANSITION DENSITIES AND SUM RULES IN DEFORMED NUCLEI. Birbrair, B. L. (AN SSSR, Leningrad. Inst. Yadernoj Fiziki). Phys. Lett., B; 57: No. 3, 223-224(7 Jul 1975).

In deformed nuclei the deformation gives rise to correlations between different multipolarity transitions. The correlation sum rules for intrinsic matrix elements are given. (NL)

**29941** GENERATOR CO-ORDINATE APPROACH TO THE BREATHING MODE. Khadkikar, S. B.; Nair, S. C. K. (International Centre for Theoretical Physics, Trieste (Italy)). Phys. Lett., B; 57: No. 3, 225-227(7 Jul 1975).

In the harmonic approximation of the generator co-ordinate method (GCM) with the Skyrme interaction it is shown that the frequency of the breathing mode is essentially the same as the semiclassical result. The accuracy of the harmonic approximation is tested in $^{16}O$. Also, a comparison is made between the adiabatic time-dependent Hartree–Fock (ATDHF) theory and an anharmonic version of the GCM. (auth)

**29942** AUGMENTATION OF THE BARRIER FOR PROMPT $\mu^-$ INDUCED FISSION. Leander, G.; Moeller, P. (Tekniska Hoegskolan, Lund (Sweden). Institutionen foer Matematisk Fysik). Phys. Lett., B; 57: No. 3, 245-247(7 Jul 1975).

The lowest muon energy levels in heavy muonic atoms are calculated for a sequence of distortions describing nuclear shapes on the way to fission. Higher multipole distortions are found to be of minor importance. (auth)

**29943** INTERPRETATION OF THE NON-ZERO ENERGY FOR $I^\pi = 0^+$ AND THE BREAK IN MALLMANN'S CURVES. Anagnostatos, G. S. (Democritus Nuclear Research Center, Athens (Greece)). Nucl. Phys., A; 246: No. 2, 445-456(21 Jul 1975).

The non-zero energy of the zero angular momentum state and the break in Mallmann's curves — two previously observed problems during the phenomenological analysis of the ground-state bands in doubly even nuclei with negative ground-state moments of inertia ($\mathcal{I}_0 < 0$) — are investigated in this paper. Their interpretation is based on the VMI model and yet uses angular speed ($\omega$) as an independent variable. It is shown that the non-zero energy corresponds to a new $0^+$ member of the ground-state bands. Moreover, for nuclei in the interval $-\frac{1}{27} \leq I(I+1)C/\mathcal{I}_0^3 \leq 0$, when $I = 2$, the existence of an additional new $2^+$ level is derived, which leads to the general pattern $I^\pi$ = g.s., $2^+$, $0^+$, $2^+$, $4^+$, $6^+$ .... The introduction of these two levels points to an interpretation of the break in the Mallmann's curves at $R_4 = 1.482$ rather than at $R_4 = 1.825$, as found by Mariscotti. (auth)

**29944** INFLUENCE OF COULOMB-EXCITED VIBRATIONS ON A NUCLEAR JOSEPHSON EFFECT. Winnik, S. L. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Dept.). Nucl. Phys., A; 247: No. 2, 382-394(4 Aug 1975).

The transfer of nucleonic Cooper pairs during the scattering of two superfluid nuclei just below the Coulomb barrier is discussed microscopically. Break-up of pairs, especially by Coulomb excitation of vibrational states, and competition from other channels reduce the transfer probability. (auth)

**29945** DOUBLE BACK BENDING IN NUCLEI. Dalafi, H. R. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 13: No. 12, 482-484(19 Jul 1975).

The solution of the Hartree–Fock–Bogolyubov equations of the cranking model with approximate particle number projection is used to calculate the moment of inertia as a function of $\omega^2$ for nuclei using a pairing plus quadrupole-quadrupole force in a single particle configuration space. The results exhibit double backbending in qualitative agreement with more realistic calculations made on $^{162}Er$ without particle number projection. (SDF)

**29946** COMPOUND NUCLEAR REACTIONS AND BLOCKING EXPERIMENTS. Uguzzoni, A. (Univ., Bologna). Lett. Nuovo Cim.; 13: No. 12, 453-459(19 Jul 1975).

A consideration is given to some of the nuclear physics aspects of crystal blocking techniques as they relate to the decay of compound nuclei. It is shown that thermal vibrations of lattice atoms play an important role in determination of the decay points of compound nuclei in the crystal. (SDF)

**29947** PARITY MIXING IN NUCLEI AS A TEST OF THEORIES OF THE WEAK INTERACTION. Box, M. A. (Univ. of Sydney); McKellar, B. H. J.; Pick, P.; Lassay, K. R. J. Phys., G (London); 1: No. 5, 493-515(20 Jun 1975).

Various manifestations of parity mixing in nuclei are studied in the hope of discriminating between weak interaction theories. It is difficult to reconcile the observed circular polarization of the photon in the reaction $n + p \rightarrow d + \gamma$ with any of the theories considered here. On the other hand, the observed asymmetry of the 110 keV photon of $^{19}F$ with respect to the spin direction of the initial state and the circular polarization of the 396 keV photon of $^{175}Lu$ are consistent with many of the theories, but rule out those which have a strong $\Delta T = 1$ part of the weak Hamiltonian. As an important byproduct of the calculations evidence is presented that the effective single-particle potential method of calculating parity mixtures is a very good approximation to the more accurate two-nucleon potential method. (auth)

**29948** NUCLEAR MATTER CALCULATION USING THE $^1S_0$ KERMODE POTENTIALS. Bhattacharyya, S. (Shibpur Dinabundhoo Coll., Howrah, West Bengal, India); Roy, M. K. J. Phys., G (London); 1: No. 5, L29-L32(20 Jun 1975).

A simple Thomas–Fermi method for nuclear matter calculations is used to examine how well the local $^1S_0$ potential introduced by Kermode can represent the actual interaction. The results obtained using this potential are compared with those found from Reid soft core potentials. (auth)

**29949** FURTHER REMARKS ON THE TOTAL PROBABILITY OF K-ELECTRON SHAKE-OFF IN BETA-DECAY. Isozumi, Y.; Shimizu, S. (Kyoto Univ.). Lett. Nuovo Cim.; 13: No. 11, 422-426(12 Jul 1975).

The total beta decay rate is evaluated in the following model: two electrons are bound in the K-shell of the parent atom with nuclear charge Z, and in the final state three electrons (two atomic and one nuclear) can make transitions to bound or continuum states of the daughter atom with Z + 1. The rates due to the K electron shake-off and K electron shake-up can be expressed as small portions of the total decay rate. Results are compared with calculations of Law and Campbell. (SDF)

**29950** MICROSCOPIC APPROACHES TO NUCLEAR ROTATIONS. NG, W. Y. Toronto; Univ. of Toronto(1973). vp. National Library of Canada, Ottawa.

Thesis (Ph. D.).

The Skyrme formula for the nuclear moment of inertia, which was first derived from a variational principle, can also be deduced from the presumption of rotational bands and intrinsic states. A formula complementary to the Skyrme formula is first developed using the same technique and approximations. A statistical interpretation indicates that this new formula and the usual Skyrme formula provide reasonable upper and lower bounds for the true inertial parameter. A third formula is then developed which yields values between these bounds. These three Skyrme-type formulas are then tested in numerical calculations in the s-d shell using the Skyrme–Hartree–Fock double self-consistency method. Several criteria for choosing the best value of the inertial parameter are discussed, and it is concluded that the third Skyrme formula gives superior results. The Skyrme–Hartree–Fock method itself is examined in a separate calculation. For the exactly solvable Elliott model, the method yields both the correct inertial parameter and the associated intrinsic wave function. It is shown that the Skyrme-type formulas can be reduced in Hartree–Fock approximation into terms depending only on the HF field and terms involving the residual interactions. It is argued that the residual interactions are responsible for the differences in results obtained from each Skyrme-type formula. Finally, the Hartree–Fock method of "projection before variation" itself is reviewed. By treating the moment of inertia parameter as a Lagrange multiplier and allowing it to vary with the J value for the different spin states in a rotational band, it is shown that better agreement with experiment can be obtained. (auth)

**29951** SOLUTIONS OF THE ELASTIC-UNITARITY EQUATION FOR A GIVEN TOTAL CROSS-SECTION. Schwarz, F. (Univ., Kaiserslautern, Ger.). Lett. Nuovo Cim.; 13: No. 13, 501-506(26 Jul 1975).

The unitarity of quantum mechanical scattering amplitudes is investigated by considering the nonlinear optimization problem of finding the largest possible contribution of the angular interval to the total cross section. Through an algorithm, the global maximum of the problem is found and two examples are evaluated. (SDF)

**29952** STRONG CHANNEL COUPLING METHOD IN DIRECT AND INVERSE PROBLEMS OF NUCLEAR PHYSICS. Zakhar'ev, B. N.; Niyazgulov, S. A.; Suz'ko, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 15-19(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2482-2486 (1974).

The possibilities for solving the inverse problems afforded by the finite dimensional expansion of the many-body wave function in a complete set of known functions are considered. A few examples in nuclear physics are cited. (SDF)

**29953** DENSITY MATRIX IN A PLANE LINEAR POTENTIAL. Tyapin, A. S. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 145-149(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2627-2632 (1974).

A plane linear potential is used to obtain an exact expression for the density matrix, enabling calculation of the densities of kinetic and potential energies of noninteracting particles in the field under consideration. It is shown that when the integral characteristics of large Fermi systems are estimated, the determining effects are those taken into account in the statistical approximation. (SDF)

**29954** AVERAGE ELECTROMAGNETIC TRANSITION STRENGTHS IN LIGHT NUCLEI. Dombrovskaya, G. S.; Lan'ko, E. V.; Shtern, G. R. (Inst. of Nuclear Physics, Tashkent). Bull. Acad. Ser. USSR, Phys. Sci.; 38: No. 12, 163-167(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2648-2653 (1974).

Results of calculations of hindrance factors, strengths, and 70% widths are tabulated for M1, M2, M3, E1, and E2 transitions. (7 tables) (SDF)

**29955** CONTRIBUTION OF COLLECTIVE MOTIONS TO THE DENSITY OF NUCLEAR EXCITED STATES. Ignatyuk, A. V. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 132-136 (1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2612-2617 (1974).

A procedure is developed for calculating the contribution to the nuclear thermodynamic functions of the interaction between particles and the static properties of nuclei. For simplicity, it is assumed that the Hamiltonian does not contain a pairing term and attention is confined to one component systems of N particles. The method is applied to $^{56}$Ni. (2 figures) (SDF)

**29956** NEW APPROACH TO THE PROBLEM OF NUCLEONS ASSOCIATED IN LIGHT NUCLEI. Barts, B. I.; Bolotin, Yu. L. Bull. Acad. Sci. USSR, Phys. Ser.; 38: No. 12, 130-131(1974).

From 24th annual conference on nuclear spectroscopy and nuclear structure; Kharkov, USSR (29 Jan 1974). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 12, 2610-2611 (1974).

A generalization of the Wheeler quasi-molecular cluster model for resonating groups is described. This model of overlapping clusters (MOC) is then used to calculate the function describing the relative motion of clusters in light nuclei. (SDF)

**29957** STRUCTURE OF THE NUCLEUS. Preston, M. A.; Bhaduri, R. K. Reading, MA; Addison-Wesley Publishing Company, Inc. (1975). 704p. $29.50.

The book is at the level of a first year graduate student and deals with the structure and physics of the nucleus and not primarily with either laboratory or mathematical techniques. The underlying emphasis is on how a nucleus is constituted through the interaction between nucleons. Chapters included are: (1) The constituents of nuclei, (2) Internucleon forces: I; (3) Nuclear moments and nuclear shapes; (4) Sizes of nuclei; (5) Internucleon forces: II; (6) Nuclear binding energies; (7) Single-particle model; (8) Correlations in nuclear matter; (9) Collective nuclear motion; (10) Hartree-Fock and particle-hole calculations; (11) Alpha radioactivity; (12) Fission. Appendixes are (A) Angular momentum, Spherical tensors, Dirac matrices; (B) Some results used in scattering theory; (C) The notation of second quantization; (D) The WKB approximation; and (E) Electromagnetic transitions. (SDF)

**29958** FOLDED POTENTIALS FOR THE DESCRIPTION OF HEAVY ION ELASTIC SCATTERING AND TRANSFER REACTIONS. Dover, C. B.; Varv, J. P. (Brookhaven National Lab., Upton, N. Y. (USA)). pp 1-14 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

A simple model is presented for the heavy ion optical potential based on the convolution of target and projectile densities with a suitably chosen nucleon-nucleon effective interaction. This model is shown to be appropriate for a number of low energy peripheral processes, such as elastic scattering and one- and two-particle transfer reactions. Application of the method to cluster states in light nuclei and relativistic heavy ion interactions is also considered. (auth)

**29959** SEMI-MICROSCOPIC APPROACH TO THE IMAGINARY PART OF THE HEAVY ION OPTICAL POTENTIAL. Toepffer, C. (University of the Witwatersrand, Johannesburg (South Africa). Dept. of Physics). pp 15-23 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

The absorption in heavy ion scattering is treated by considering the Pauli-forbidden regions of phase space for the scattering of bound nucleons. An energy dependent imaginary potential is derived which is both surface transparent and strongly absorptive in the interior region. The model is sufficient to explain the main features of the $^{16}$O-$^{16}$O excitation functions up to 80 MeV. (auth)

**29960** FUSION BARRIERS. Krappe, H. J. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F. R. Germany). Bereich Kern- und Strahlenphysik). pp 24-38 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

Various models for the calculation of heavy-ion interaction barriers in the sudden approximation are compared. Their relation to experimental reaction thresholds and optical potentials is discussed. The relation between interaction, fusion, and fission barriers is explained within the frame of a multidimensional model. (auth)

**29961** USE OF SEMICLASSICAL QUANTITIES IN TRANSFER REACTIONS. Koerner, H. J. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Department). pp 39-58 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harnery, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

Semiclassical quantities are used to discuss several features of transfer and inelastic scattering reactions induced by heavy ions. Experimental data on absorption phenomena in elastic scattering and the relative importance of quasielastic channels are presented. Transfer probabilities and the enhancement of two-nucleon transfer cross sections due to correlated nuclear structure are discussed. The question of two-step simultaneous and successive transfer reactions is investigated for $^{16}$O, $^{18}$O induced two neutron transfer reactions, and the "exotic" ($^{16}$O, $^{15}$C) reaction. (auth)

**29962** OSCILLATIONS IN THE ANGULAR DISTRIBUTIONS OF HEAVY-ION TRANSFER REACTIONS. Garrett, J. D. (Brookhaven National Lab., Upton, N. Y. (USA)). pp 59-85 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

Oscillations in the angular distributions are established as a general feature of heavy-ion induced, few-nucleon transfer reactions at incident energies sufficiently above the Coulomb barrier. For proper Q-matching with incident and exiting energies well above the Coulomb barrier, the angular position of the most forward maxima in the differential cross section is characteristic of the transferred angular momentum. The threshold for such oscillations is particularly sensitive to the absorptive potential near the nuclear surface requiring potentials that are strongly absorbing in the nuclear interior but nearly transparent at the surface. Evidence also is presented for an energy dependent surface absorption. Certain anomalous cases where the oscillating cross sections are predicted to be out of phase with the data are discussed. (auth)

**29963** SEMI-CLASSICAL DESCRIPTION OF ELASTIC AND INELASTIC HEAVY ION SCATTERING. Malfliet, R. A. (Rijksuniversiteit Groningen (Netherlands). Instituut voor Kernfysisch Versneller). pp 86-101 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

A semi-classical approximation derived from Feynman's path-integral representation of the S-matrix is applied for the case of elastic and inelastic heavy ion scattering. The method was modified to allow for complex potentials and can be extended readily for more complicated reactions. Comparison of the calculated elastic and inelastic cross sections as well as the individual phase shifts with the same quantities obtained quantum mechanically, demonstrates the quantitative power of the method. (auth)

**29964** WAVE MECHANICAL ASPECTS OF HEAVY ION COLLISIONS. Frahn, W. E. (Cape Town Univ. (South Africa). Dept. of Physics). pp 102-126 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F. R. Germany (2 Oct 1974).

A unified quantal description of the wave mechanical and semiclassical aspects of heavy ion collisions is given by means of closed expressions derived from partial-wave expansion of the transition amplitudes. The results depend entirely on the asymptotic properties of the scattering wave functions (the partial-wave S matrix). It is shown, in particular, how the "refractive" features of semiclassical potential scattering are changed, in the presence of absorption, into characteristic quantal interference patterns of "diffractive" type. Only the simplest idealized limits are considered as examples of how insight is gained into the physical mechanisms that operate under various scattering conditions. Elastic scattering, inelastic scattering, and direct transfer reactions are described and the close physical connection between these processes is made explicit. (auth)

**29965** SURFACE WAVES AND SURFACE RESONANCES IN HEAVY-ION REACTIONS. McVoy, K. W. (Wisconsin Univ., Madison (USA). Dept. of Physics). pp 127-139 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F.R. Germany (2 Oct 1974).

The relations between surface waves, rainbows and refractive shadows are examined. These all appear to be Regge-pole phenomena, which seem to play a major dynamical role in heavy-ion transfer reactions and backward-hemisphere $\alpha$-scattering. (auth)

**29966** CRITICAL DISCUSSION OF THE CONCEPT OF CRITICAL ANGULAR MOMENTUM IN HEAVY ION REACTIONS. Lefort, M. (Paris-11 Univ., 91-Orsay (France). Inst. de Physique Nucleaire). pp 274-294 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F.R. Germany (2 Oct 1974).

After a presentation of the concept of critical angular momentum, $l_{(cr)}h/2\pi$, and its relation to the compound nucleus cross section, the experimental methods used to determine $l_{(cr)}$ are discussed. Criteria for testing the compound nucleus formation are presented. Then a number of experimental results is given, mainly on argon induced reactions which show how $l_{(cr)}h/2\pi$ strongly depends on the entrance channel and particularly on the bombarding energy. A critical distance of approach, $R_{(cr)}$, is extracted as the relevant parameter limiting complete fusion of two heavy ions. It corresponds to an approximate formulation for the compound nucleus cross section $\sigma_{(CN)} = \pi R^2_{(cr)}(1 - V_{(cr)}/E)$ where $V_{(cr)}$ is the Coulomb + nuclear potential at the distance $R_{(cr)}$ between the centers. The fission barrier for a rotating nucleus is discussed, as well as the separation between evaporation residues and fission. Finally, the possibility of existence of an inferior critical angular momentum for very heavy projectiles is presented. (auth)

**29967** FRICTION MODEL FOR HEAVY-ION COLLISIONS AND ITS APPLICATION TO HEAVY ION FUSION AND DEEP INELASTIC REACTIONS. Gross, D. H. E.; Kalinowski, H.; De, J. N. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F.R. Germany). Bereich Kern- und Strahlenphysik). pp 194-220 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F.R. Germany (2 Oct 1974). With figs. and tabs.; 36 refs.

Heavy ion collisions leading to fusion or deep inelastic direct reactions are described by a simple classical model. The ions are assumed to move along classical trajectories under the influence of frictional forces. With the use of only two parameters fixed simultaneously for all systems the systematics of the existing data on fusion cross sections and deep inelastic collisions could be reproduced. Especially the model gives a simple explanation of the focussing effect observed in Kr-induced deep inelastic collisions. The amount of energy loss observed in these collisions is qualitatively reproduced but quantitatively still differs considerably. (auth)

**29968** SUMMARY OF THE SYMPOSIUM ABOUT ASPECTS OF HEAVY ION COLLISIONS. Hansen, O. (Copenhagen Univ. (Denmark). Niels Bohr Inst.; Los Alamos Scientific Lab., N. Mex. (USA)). pp 295-307 of Classical and Quantum Mechanical Aspects of Heavy Ion Collisions. Harney, H. L. (ed.). Berlin; Springer-Verlag (1975).

From classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F.R. Germany (2 Oct 1974).

A brief summary is given of the symposium on classical and quantum mechanical aspects of heavy ion collisions. (auth)

**29969** ERICSON FLUCTUATIONS AND THE DISTRIBUTION OF RANDOM S-MATRIX ELEMENTS. Tepel, J. W. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Z. Phys., A; 273: No. 1, 59-63(May 1975).

1 fig.; 2 tabs.; 13 refs.

Starting from a random matrix model for nuclear reactions, it is shown that the fluctuating S-matrix elements in general have a non-Gaussian distribution. The consequences of this for Ericson fluctuations are pointed out. In the absence of direct reactions symmetry properties of the distribution function lead to simple expressions for the cross section correlation functions. In particular a formula for calculating the cross section auto-correlation function is presented. (auth)

**29970** CONDITION FOR A VANISHING CROSS SECTION AT $\Theta = \pi/2$ IN BARSHAY-TEMMER REACTIONS. Braun-Munzinger, P.; Gelbke, C. K.; Harney, H. L.; Agassi, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F.R. Germany)). Z. Phys., A; 273: No. 1, 57-58(May 1975).

8 refs.

The symmetry property of the transition matrix for a reaction producing an isobaric multiplet (or identical particles) is derived from the generalized Pauli principle without any specific assumptions concerning the reaction mechanism. In contrast to previous predictions it is shown that for odd partial waves in the exit channel the cross section will generally not vanish at $\Theta = \pi/2$ if the channel spin projections of the initial and final channels may be different. (auth)

**29971** TEST OF A SEPARABLE APPROXIMATION TO A LOCAL SOFT-CORE POTENTIAL IN THE THREE-BODY SYSTEM. Alt, E. O. (Mainz Univ. (F.R. Germany). Inst. fuer Physik); Bakker, B. L. G. (Vrije Universiteit, Amsterdam (Netherlands). Natuurkundig Lab.). Z. Phys., A; 273: No. 1, 37-42(May 1975).

8 figs.; 5 tabs.; 17 refs.

Three-nucleon observables below the break-up threshold are calculated employing the pole approximation to the soft-core Malfliet-Tjon potentials. The results are compared in detail to those obtained with the local potentials and to those calculated with the usual Yamaguchi interactions. (auth)

**29972** BREMSSTRAHLUNG IN HEAVY-ION REACTIONS. Jakubassa, D. H.; Kleber, M. (Technische Univ. Muenchen, Garching (F.R. Germany). Physik-Department). Z. Phys., A; 273: No. 1, 29-35(May 1975).

4 figs.; 16 refs.

Bremsstrahlung processes induced by heavy ions are investigated: nuclear dipole and quadrupole radiation, radiation from bound target electrons into the continuum and secondary electron bremsstrahlung (SEB), which contribute to the background of the x-ray spectra. A comparison with experiment is presented. (auth)

**29973** APPROXIMATE PROJECTION OF ANGULAR MOMENTUM AND PARTICLE NUMBER IN HEAVY NUCLEI. Dalafi, H. R.; Mang, H. J. (Technische Univ. Muenchen, Garching (F.R. Germany). Physik-Department); Ring, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Z. Phys., A; 273: No. 1, 47-55(May 1975).

6 figs.; 2 tabs.; 32 refs.

The problem of symmetry violations in Hartree-Fock-Bogoliubov wave functions is handled by projection techniques. For the cases of strong and weak symmetry violations, approximate formulas of the projected energy are given. They allow an approximate projection before the variation for heavy nuclei. The methods are applied numerically to some model calculations for strong and weak deformations. (auth)

**29974** SECOND-CLASS CURRENTS IN $0^- \rightarrow 0^+$ AND UNIQUE NUCLEAR $\beta$ TRANSITIONS. Eman, B.; Tadic, D. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)); Krmpotic, F. (La Plata Univ. Nacional (Argentina). Departamento de Fisica); Szybisz, L. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Experimentelle Kernphysik; Karlsruhe Univ. (TH) (F.R. Germany). Inst. fuer Experimentelle Kernphysik). Z. Phys., A; 273: No. 1, 89-96(May 1975).

2 figs.; 4 tabs.; 30 refs.

The induced pseudotensor contribution to $0^- \rightarrow 0^+$ and unique nuclear $\beta$ transitions was analyzed starting from two possible forms of the nonrelativistic Hamiltonian. The role of mesonic corrections and mesonic second-class currents was discussed. (auth)

**29975** SUDDEN APPROXIMATION AS APPLIED TO (d,p) REACTIONS. Gridnev, K. A.; Hefter, E. F. (Leningradskij Gosudarstvennyj Univ. (USSR). Nauchno-Issledovatel'skij Fizicheskij Inst.). Z. Phys., A; 273: No. 1, 99-104(May 1975).

3 figs.; 1 tab.; 34 refs.

Results of the sudden approximation are compared to predictions of the conventional DWBA and to experiment. The asymptotic spectroscopic amplitude obtained by the sudden approximation is interpreted as the maximum limit of its true value. The main approximations of the model are asserted to stem from violations of the completeness of the virtual neutron wave functions and the crude application of the sudden approximation. It appears impossible to separate these two points. Improvements of the model are discussed. (auth)

**29976** MODIFICATION OF THE REFERENCE SPECTRUM METHOD FOR SOLVING THE BETHE–GOLDSTONE EQUATION FOR FINITE NUCLEI. Bal'butsev, E. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 23: No. 3, 395-398 (Jun 1975). (In Russian).

The reference spectrum method is modified in such a way that only algebraic operations are required to obtain the reaction matrix elements for finite nuclei. No differential equations should be solved. The Pauli operator is treated exactly. A one-particle potential can be taken arbitrarily, but the two-particle interaction must not have a hard core. (auth)

**29977** CONSTRUCTION OF THE COLLECTIVE HAMILTONIAN IN THE MICROSCOPIC MODEL OF NUCLEI. II. Jolos, R. V.; Denau, F.; Jansen, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 23: No. 3, 374-382(Jun 1975). (In Russian).

Based on the collective Hamiltonian, which is constructed by the method of the boson representations of fermion operators, expressions are obtained for the potential energy, mass coefficients and moments of inertia. In the framework of a simple model, the comparison of the potential energies, which are found by the self-consistent field method and by the method suggested, is made. (auth)

**29978** COLLECTIVE MASS PARAMETERS IN HEAVY ION SCATTERING. Fink, H. J.; Scheid, W.; Greiner, W. (Univ., Frankfurt am Main). J. Phys., G (London); 1: No. 6, 685-699 (1 Aug 1975).

In a model which describes the scattering of heavy ions by the relative distance between the nuclei and collective degrees of freedom, the structure of the kinetic energy depending on the collective coordinates and the relative distance is investigated. A Hamiltonian for the scattering process is derived. (auth)

**29979** COUPLED CHANNEL REACTION THEORY OF ONE- AND TWO-NUCLEON TRANSFER REACTIONS. Abdallah, A. K. Austin, TX; Univ. of Texas (1974). 89p. University Microfilms Order No. 75-4307.

Thesis (Ph. D.).

First, a simple formulation of the coupled-channel Born approximation (CCBA) is presented, for the case where the spin-dependent terms in the optical potential can be ignored. The formalism is particularly useful in reducing the computer time required when numerical calculations are carried out for one-nucleon transfer reactions. The formalism is then applied to calculate one-nucleon pickup and stripping reactions such as (p,d), (h,alpha), (d,t) and (h,d) all leading to the 1.61 MeV $^1/_2^+$, the 3.4 MeV $^1/_2^+$, and the $^5/_2^+$ ground state in mass-25 nuclei. It is shown that the observed cross sections are all reasonably well reproduced by the coupled-channel-Born-approximation. Next, the detailed physical aspects of the multistep mechanism is studied. Particularly, an attempt is made to clarify under what conditions we expect to get a large effect from inelastic scattering. It is shown that indirect processes are more important for poorly matched reactions. A simple method for taking inelastic coupling into account has been known for some time. It boils down to a modification of the radius parameters of the optical potentials to be used in the standard distorted wave Born approximation, by an amount proportional to the deformation parameter. In the final part of this work it is shown that in such a procedure spurious second order terms are introduced into the transition amplitude. These terms are eliminated and then the new approximation is applied to (p,t) reactions on vibrational nuclei and to reorientation effects on deformed nuclei. It is shown that, in most cases, the new approximation gives a better fit to CCBA. (auth)

**29980** PROPERTIES OF AN EQUATION WITH A NEGATIVE COLLECTIVE MASS. Cugnon, J. (Paris-11 Univ., 91- Orsay (France). Inst. de Physique Nucleaire). Phys. Lett., B; 57: No. 4, 320-322(21 Jul 1975).

The properties of a Schroedinger equation involving a variable collective mass, which can be negative, are investigated within a simple model. In particular, it is shown that such an equation can yield a ground state below the minimum of the potential. (auth)

**29981** NON AXIAL VIBRATIONS IN THE ADIABATIC APPROXIMATION. Grammaticos, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91- Gif-sur-Yvette (France). Service de Physique Theorique). Phys. Lett., B; 57: No. 4, 306-308(21 Jul 1975).

The adiabatic time-dependent Hartree-Fock method, together with a scaling assumption is used for the calculations of the mass parameters associated with nonaxial quadrupole ($\gamma$) collective vibrations, and for the study of the splitting of the giant quadrupole resonance in deformed nuclei. (auth)

**29982** YRAST BANDS AND HIGH-SPIN POTENTIAL ENERGY SURFACES. Bengtsson, R.; Larsson, S. E.; Leander, G.; Moeller, P.; Nilsson, S. G.; Aaberg, S. (Tekniska Hoegskolan, Lund (Sweden)); Szymanski, Z. (Warsaw Univ. (Poland). Instytut Fizyki Teoretycznej). Phys. Lett., B; 57: No. 4, 301-305(21 Jul 1975).

The yrast sequence of states of high angular momenta is studied. The modified-oscillator field with the inclusion of an $\omega J_x$ term to describe the effects of nuclear rotation forms the basis for the calculation of microscopic energies. The macroscopic energies are provided by surface and Coulomb energies, and the rotational energy corresponding to rigid rotation. (auth)

**29983** THE LORENTZ-LORENZ CORRECTION. Baym, G. (Illinois Univ., Urbana (USA). Dept of Physics); Brown, G. E. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Nucl. Phys., A; 247: No. 3, 395-410(11 Aug 1975).

The Ericson–Ericson Lorentz–Lorentz correction in the propagation of pions in matter is derived in a relativistic theory for general pion frequency and wave vector, in terms of the nucleon-nucleon pair correlation function. The relation to the electromagnetic Lorentz-Lorenz correction is described. It is shown that $\rho$-meson exchange between nucleons can be expected to give contributions to the Lorentz-Lorenz correction comparable to those from $\pi$-mesons. The precise magnitude of the $\rho$-contributions depends sensitively on the detailed behaviour of the two-body correlation function, since the range of the interaction through $\rho$-exchange is comparable to that of the repulsive correlations. (auth)

**29984** PROFILE FUNCTIONS FOR COULOMB EXCITATION AT HIGH ENERGIES. Jaeckle, R.; Pilkuhn, H. (Karlsruhe Univ. (TH) (F. R. Germany)). Nucl. Phys., A; 247: No. 3, 512-528(11 Aug 1975).

The profile functions for C1, E1, M1, and E2 excitation of hadrons or nuclei in collisions with other nuclei are calculated for high, but not necessarily relativistic, energies. Cross sections for C1, E1, and M1 excitation are calculated in a model using total absorption at impact parameters $b < R$, and a generalized Weizsäcker–Williams formula is established. Effects of the target form factor are included. At low energies, the C1 + E1 cross section goes through a minimum. (auth)

**29985** MOMENTUM-SPACE OBEP, TWO-NUCLEON AND NUCLEAR MATTER DATA. Holinde, K.; Machleidt, R. (Bonn Univ. (F. R. Germany). Inst. fuer Theoretische Kernphysik). Nucl. Phys., A; 247: No. 3, 495-520(11 Aug 1975).

Several momentum-space OBEP are investigated regarding their results for the two-nucleon and nuclear matter system. The large discrepancies occurring in nuclear matter binding are traced back mainly to the different descriptions of NN data. The influence of relativistic effects and different scattering equations is discussed and turns out to be small. (auth)

**29986** ANTIPAIRING EFFECTS IN THE COLLECTIVE NUCLEAR MOTION AND THEIR RELEVANCE TO THE SADDLE TO SCISSION DESCENT IN FISSION. Moretto, L. G. (California Univ., Berkeley (USA). Dept. of Chemistry). Phys. Lett., B; 57: No. 4, 317-319(21 Jul 1975).

The dependence of the pairing correlation upon collective velocity is studied in terms of the classical equations of motion. A decrease in pairing with increasing collective velocity similar to the Coriolis antipairing effect is predicted. The consequences for nuclear viscosity and for the saddle-to-scission descent are discussed. (auth)

# PHYSICS (RADIATION AND SHIELDING)

## Radiation Physics

*Refer also to abstracts 29303 and 29994.*

**29987** A METHOD FOR DETERMINATION OF NUCLEAR AND ELECTRONIC STOPPING POWER PARAMETERS. Bister, M.; Anttila, A.; Kleinonen, J. (Helsinki Univ. (Finland). Dept. of Physics). Phys. Lett., A; 53: No. 6, 471-472(28 Jul 1975).

It is shown that by use of Doppler-shift attenuation measurements of γ-rays and by use of range measurements, the correction factors for the nuclear and electronic stopping power equations can be determined. (auth)

## Radiation Protection Standards

**29988** RADIATION PROTECTION IN MEDICINE. Some Essential Regulations. Jeiter, W. (Bundesministerium fuer Arbeit und Sozialordnung, Bonn (F. R. Germany)). Roentgenpraxis; 28: No. 3, 61-72(Mar 1975). (In German).

The ICRP recommendations and the basis EURATOM standards are summarized. Some regulations of the X-ray Ordinance (RoeV), i.e., their content with regard to radiation protection, are discussed in more detail. (GE)

**29989** X-RAY ORDINANCE (RoeV). Its Practical Influences in the Field of Human Medicine. Schlungbaum, W. (Staedtisches Krankenhaus Spandau-Nord, Berlin (F. R. Germany). Strahleninstitut). Ther. Gegenw.; 113: No. 12, 2134-2154(Dec 1974). (In German).

The paper gives a critical evaluation of the most important regulations of the RoeV: scope of the RoeV, controlled area, duty of recording, maximum doses and their measurement, as well as information on the RoeV and on biological radiation effects. (GE)

**29990** RADIATION PROTECTION; DATA AND PROBLEMS. III. Persons and Facilities Under Supervision In Accordance With The 1st Radiation Protection Ordinance. Umwelt (Inf. Bundesminist. Innern); No. 40, 5-7(Apr 1975). (In German).

3 figs.; 2 tabs.

A synoptical table is given on the number of persons and facilities under supervision in accordance with paragraph 36 of the 1st SSVO as per December 31st, 1973 (figures given by the supervising authorities of the federal lands). (GE)

**29991** STRAHLENSCHUTZKURS FUER AERZTE. Kurs-Lehrbuch fuer die Anwendung von Roentgenstrahlen und Radioaktiven Stoffen in der Medizin. (Course of Instruction in Radiation Protection for Physicians. Textbook in Courses for the Application of X-Rays and Radioactive Materials in Medical Practice). Stieve, F. E. (ed.). Berlin; Hoffmann (1974). vp. (In German).

With figs., tabs. and refs.

The textbook is meant to be a foundation for the radiation protection course for medical personnel for the acquisition of technical knowledge according to the regulations of the X-ray ordinance. In the first part, the fundamentals of radiation physics and radiobiology are gone into as well as the national and international laws and guidelines in the field of radiation protection. Furthermore, the tasks and duties of those responsible for radiation protection are given. The second part serves as a foundation of a special course in radiation protection when doing X-ray investigations. In addition to a brief survey on X-ray equipment as well as indications about apparative and constructive radiation protection, the radiation protection of personnel and patients is gone into in detail. The significance of radiation injuries and their recognition is indicated. The laws, standards and authoritative measures are also dealt with. At the end of each part, there are practical tasks as a basis for practical exercises. (GE)

**29992** NEW HEALTH AND SAFETY ACT AS IT RELATES TO OCCUPATIONAL RADIATION EXPOSURE. Ryer, F. H. (Dept. of Labor, Washington, DC). Health Phys.; 29: No. 1, 207-212(Jul 1975).

The impact of the Occupational Safety and Health Administration (OSHA) law which empowers the Secretary of Labor to promulgate health and safety standards is discussed. Initial or early standards, emergency temporary standards, and permanent standards are presented. A timetable for promulgating a permanent standard is outlined. The standard, 1910.96, on ionizing radiation, is reviewed. Requirements and the enforcement of this standard, as well as its relationship to other Federal and State agencies, are explained. It is also explained why Atomic Energy Commission licensees who have x-ray equipment or accelerators may receive inspections and citations from OSHA. The responsibility of OSHA personnel in the monitoring of ionizing radiation from x-ray devices for inspection of hand-carried luggage in airline terminals is mentioned. Also explored is the rationale for inspection by OSHA of AEC licensees using other nonlicensed radiation sources. The employee's rights and privileges, violations, citations, and penalties are outlined. It is important to maintain a proper balance between exposure benefit and risk. The worker must not be unnecessarily exposed, but at the same time, research, development, and beneficial utilization of radiation must not be unduly hampered or restricted. (auth)

**29993** GUIDELINES FOR PERSONNEL DOSIMETRY WITH REGARD TO THE X-RAY ORDINANCE AND THEIR PRACTICAL SIGNIFICANCE. Nitschke, J. (Bundesgesundheitsamt, Neuherberg/Muenchen (F. R. Germany). Abt. fuer Strahlenhygiene). Arbeitsschutz (Cologne); No. 10, 265-269(Oct 1974). (In German).

4 tabs.; 4 refs.

The guidelines under paragraph 40 of the German X-Ray Ordinance (RoeV) about the extent and type of measurements of the personnel dose and its evaluation are discussed in terms of their character as "instructions for use" in implementing the rules for personnel dosimetry included in the RoeV. They clarify the conditions under which exceptions can be granted under general aspects and quote practical examples about measurements of the personnel dose. The guidelines by simplifying agreements in addition establish a connection between the provisions of the RoeV about personnel dosimetry and those about maximum permissible doses. This relates to the interpretation and evaluation of the measured results. (GE)

## Radiation Source Calibration and Standardization

*Refer also to abstracts 28059, 28271, and 28275.*

**29994** (ORNL-TM-4841) NEUTRON AND SECONDARY-GAMMA-RAY TRANSPORT CALCULATIONS FOR 14-MeV AND FISSION NEUTRON SOURCES IN AIR-OVER-GROUND AND AIR-OVER-SEAWATER GEOMETRIES. Pace, J. V. III; Bartine, D. E.; Mynatt, F. R. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 48p. Dep. NTIS $5.50.

Radiation transport calculations were performed with the DOT-III code for a 14-MeV neutron source and a tactical weapon fission neutron source in air-over-ground and air-over-seawater geometries. The source heights were 1, 50, 100, 200, and 300 m for the air-over-ground calculations and 50 m for the air-over-seawater calculations. The results were obtained as neutron and secondary-gamma-ray fluxes throughout a cylindrical system having a height of approximately 1300 m and a radius of about 1500 m, the lower 50 cm of the cylinder being either ground or seawater. Several ionization and tissue-dose response functions were applied to the fluxes obtained for positions on the interfaces. The air-over-ground results indicate that an optimal source height can be specified for the maximum neutron dose at a given ground range. They also show the source height and ground-range combinations for which the air-over-ground neutron and gamma-ray tissue doses are greater than those at equivalent ranges in infinite air. (78 figures, 7 tables) (auth)

**29995** APPROXIMATIVE DOSE CALCULATION IN THE ENVIRONMENT OF SEALED RADIUM PREPARATIONS AND THEIR COMBINATION WITH DOSE CALCULATIONS FOR PERCUTANEOUS IRRADIATION. Steinstraesser, A.; Leetz, H. K. (Universitaet des Saarlandes, Homburg/Saar (F.R. Germany). Inst. fuer Biophysik). Strahlentherapie; 149: No. 5, 463-470(May 1975). (In German).

9 figs.; 9 refs.

Discussions are given about different possibilities of dose calculation with an electronic computer in the environment of radium applicators. First of all, it is demonstrated that no time can be saved in the exact calculation, even if varying mathematical methods are chosen. Possibilities are discussed in order to save calculation time by approximation procedures; methods are quoted—one less and one more complicated—for realizing such

a procedure. Furthermore, the reasons are mentioned that are contrary to an immediate inclusion of this calculation into the physical irradiation planning. Possibilities to overcome these difficulties are cited. (auth)

**29996** KLINISCHE DOSIMETRIE. Interstitielle und Kontaktbestrahlung Mit Umschlossenen γ- und Betastrahlenden Radioaktiven Stoffen. Entwurf. (Clinical Dosimetry. Interstitial, Intracavitary and Percutaneous Irradiation with Sealed γ and β Sources. Draft). Berlin; Beuth (Feb 1975). 5p.
2 figs.; 1 tab.; 9 refs.
Dose determination and irradiation planning are discussed. (GE)

**29997** KLINISCHE DOSIMETRIE. Therapeutische Anwendung Gebuendelter Roentgen-, γ- und Elektronenstrahlung. Entwurf. (Clinical Dosimetry. Therapeutical Application of X-ray, Gamma-ray and Electron Beams. Draft). Berlin; Beuth (Feb 1975). 11p.
2 figs.; 7 tabs.; 23 refs.
The paper covers determination of radiation qualities, dose distributions with basic definitions, phantom measurements, determination of doses and dose distributions in the body with different methods of irradiations, and alternations. (GE)

**29998** DEPTH-DOSE MEASUREMENTS OF d-T NEUTRONS FOR RADIOTHERAPY APPLICATIONS. Broerse, J. J.; Broers-Challiss, J. E.; Mijnheer, B. J. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut TNO; Antoni van Leeuwenhoek Hospital, Amsterdam (Netherlands). Radiotherapy Dept.). Strahlentherapie; 149: No. 6, 585-596(Jun 1975).
7 figs.; 4 tabs; 24 refs.
In connection with clinical applications of fast neutrons, depth-dose measurements have been carried out for collimated 15 MeV neutron beams at various source-to-skin distances, using different phantoms of the upper part of the human body. The distribution of fast, thermal and intermediate neutron dose or kerma and gamma dose over the phantoms was determined with tissue-equivalent ionization chambers, gold foils with and without cadmium covers and a shielded Geiger-Mueller counter, respectively. In order to determine the tumour dose and the exit dose for the irradiation of patients with pulmonary metastases, depth-dose measurements have been performed for an inhomogeneous phantom containing lung-equivalent material. The measurements indicate a considerable difference in depth dose with respect to the dose distribution in a homogeneous phantom. Measurements with sulphur activation detectors to monitor the exit dose are discussed and compared with the results obtained in the actual patient irradiations. (auth)

**29999** CONCEPTS OF MICRODOSIMETRY. I. Quantities. Kellerer, A. M.; Chmelevsky, D. (Columbia Univ., New York (USA). Radiological Research Lab.). Radiat. Environ. Biophys.; 12: No. 1, 61-69(Jun 1975).
1 fig.; 15 refs.
This is the first part of an investigation of microdosimetric concepts relevant to numerical calculations. The definition of the microdosimetric quantities are reviewed and formalized, and some additional conventions are adopted. The common interpretation of the quantities in terms of energy imparted to spherical sites is contrasted with their interpretation as the result of a diffusion process applied to the initial spatial pattern of energy transfers in the irradiated medium. (auth)

## Shielding Calculations and Experiments

*Refer also to abstract 30243.*

**30000** RADIATION LEAKAGE FROM NARROW GAPS IN SHIELDS. Haworth, R.; Liquorish, R. A. C.; Taylor, C. B. G. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Nucl. Eng. Des.; 32: No. 3, 428-437(1975).
Clearance gaps around plugs and other movable components can be a significant source of radiation leakage from large casks. There is, however, a lack of quantitative information upon which a designer can base his choice of clearance dimension. The factors underlying this problem are discussed, and expressions based on a single-scatter approximation are derived from some typical geometries. Calculated data is presented for iron, lead and uranium shields, for cobalt-60 and caesium-137 gamma radiation. Experiments to check the expressions are described. It is shown that the accuracy of this method is sufficient for dealing with practical problems. (auth)

# PHYSICS (THEORETICAL)

**30001** ONE-DIMENSIONAL MANY-BODY PROBLEMS WITH PAIR INTERACTIONS WHOSE EXACT GROUND-STATE WAVE FUNCTION IS OF PRODUCT TYPE. Calogero, F. (Univ., Rome). Lett. Nuovo Cim.; 13: No. 13, 507-511(26 Jul 1975).

The most general solution of functional equations relating to one-dimensional many-body problems with pairing interactions is obtained. A method is introduced that generates novel many-body models with more than one type of particles, whose exact ground state wave functions are of product type. (SDF)

## General

*Refer also to abstract 29634.*

**30002** (JINR-R-5-8113) ON STATIONARY SOLUTIONS OF THE SCHROEDINGER EQUATION WITH THE SELF-CONSISTENT POTENTIAL SATISFYING THE BOUSSINESQ EQUATION. Makhan'kov, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1974. 8p. (In Russian). INIS.

An equation for the self-consistent potential of the Schroedinger equation was developed and found to correctly describe solutions in the resonance region $M \rightarrow I'$. Approximate solutions for the system were also found and are discussed. (tr-auth)

**30003** (JINR-R-5-8274) PARTICULAR VALUES OF THE JACOBIAN ELLIPTICAL FUNCTIONS IN THE POINTS MULTIPLE TO K/3. Bogoslovskaya, M. K.; Bogoslovskii, G. Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 7p. (In Russian). INIS.

Values were found for the Jacobian elliptical functions at special points. Certain special functions were found in the form of clear functions of the modulus k. A new theory is given for a total elliptical integral of the first type, K(k), in which the sub-integral function is monitored at all integration intervals. (tr-auth)

**30004** SPONTANEOUS BREAK-DOWN OF SYMMETRY IN THE STATIC ULTRA-LOCAL APPROXIMATION OF THE $g\phi^4$ QUANTUM FIELD THEORY. Scarpetta, G.; Vilasi, G. (Univ., Salerno, Italy). Nuovo Cim., 28A: No. 1, 62-74(1 Jul 1975).

The spontaneous break-down of symmetry in the exactly solvable Euclidean static ultra-local model is studied. It is shown that there exists always a suitable interval for the arbitrary constants from which the Green's functions depend, and in correspondence a suitable value $\lambda_c$ of the coupling constant, such that for $\lambda < \lambda_c$ the theory admits the symmetric solution, while for $\lambda \geq \lambda_c$ the theory predicts also the possibility of the spontaneous break-down of the discrete symmetry. (4 figures) (auth)

**30005** INVARIANT LAGRANGIAN THEORY OF THE POISSON BRACKET FOR SYSTEMS WITH CONSTRAINTS. Allcock, G. R. (Liverpool Univ.). Proc. R. Soc. (London), Ser. A; 344: No. 1637, 175-198(24 Jun 1975).

A new and improved universal theory of the Poisson bracket is described and validated. A simple coordinate-invariant system of simultaneous linear algebraic equations is presented, by which both the Poisson bracket and its Fermi–Dirac counterpart can readily be calculated for Lagrangian dynamical systems with arbitrarily complicated constraint structure. (auth)

**30006** IRREDUCIBLE MULTIPLIER COREPRESENTATIONS OF THE EXTENDED POINCARE GROUP. Shaw, R.; Lever, J. (Hull Univ. (UK). Dept. of Applied Mathematics). Commun. Math. Phys.; 38: No. 4, 279-297(Nov 1974).

The irreducible multiplier corepresentations of the extended Poincare group are, for positive and zero mass, determined by generalized inducing from a generalized little group. This approach is compared with the previous one of Wigner. For $m > 0$, and any spin j, a particular realization is noted which is manifestly covariant on all four components of P. The choice of covering group for P is discussed, and reasons are given for preferring a group for which S and T generate the quaternion group of order 8. (auth)

**30007** EXACTLY SOLVABLE ONE-DIMENSIONAL MANY-BODY PROBLEMS. Calogero, F. (Inst. of Theoretical and Experimental Physics, Moscow). Lett. Nuovo Cim.; 13: No. 11, 411-416(12 Jul 1975).

The Lax technique for solving N-body problems is extended to a class of many body problems with two-body one dimensional forces. Some specific properties of the dynamical behavior of these systems are outlined and a simple trick that generates novel solvable $(N_1 + N_2)$-body problems involving $N_1$ particles of one kind, and $N_2$ of another is introduced. (SDF)

**30008** IDENTITY OF THE SU(1,1) AND SU(2) CLEBSCH–GORDAN COEFFICIENTS COUPLING UNITARY DISCRETE REPRESENTATIONS. Rasmussen, W. (Univ., Cologne). J. Phys., A. (London); 8: No. 7, 1038-1047(Jul 1975).

The Clebsch–Gordan (CG) coefficients coupling two positive discrete series or two negative discrete series of irreducible unitary representations (IUR) of SU(1,1) are shown to be identical to SU(2)CG coefficients. The transformations changing the indices of the SU(1,1)CG coefficients into those of the identical SU(2)CG coefficients are derived and shown to transform the SU(2)CG coefficients into SU(1,1)CG coefficients. The associated phases are discussed. General index transformations are derived and used to generate SU(2)CG coefficient symmetries, among which are some of the more abstract Regge symmetries. A simple invariance property of the intermediate SU(1,1)CG coefficients is at the base of the symmetries. Demonstrations are carried out with coexistent IUR of the tensor product groups SU(1,1) SU(1,1) and SU(2) SU(2) embedded in a simple encompassing group structure, the most degenerate discrete IUR of SU(2,2). (auth)

**30009** ESSENTIALS OF PADE APPROXIMANTS. Baker, G. A. Jr. New York; Academic Press (1975). 317p. $26.00.

The discussion of the essentials of Pade approximants includes algebraic properties, convergence theory, the series of Stieltjes and Poiya, and generalizations and applications. (JFP)

**30010** FUNCTIONAL-INTEGRATION METHODS FOR THE SCHROEDINGER EQUATION. Bove, A. (Univ., Bologna); Fano, G.; Turchetti, G.; Teolis, A. G. Nuovo Cim.; 28B: No. 2, 363-376(11 Aug 1975).

A method for computing eigenvalues and eigenvectors of the Schroedinger equation is presented. The method consists in a numerical approximation to the path integral combined with the moment method. An estimate of the error and a discussion of the choice of the parameters is given. S-wave eigenvalues are computed for some typical two-body problems. (auth)

**30011** SOLUTION OF DIRAC EQUATION FOR AN ELECTRON IN CROSSED ELECTROMAGNETIC FIELDS. Vorontzov, V. I.; Mausunbayer, S. S. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). Phys. Lett., A; 53: No. 6, 435-437(28 Jul 1975).

The quantum theory of strophotron resonance in crossed electromagnetic fields is worked out in relativistic approximation on the basis of the Dirac equation. (auth)

**30012** WAVEPACKET PATH INTEGRAL FORMULATION OF SEMICLASSICAL DYNAMICS. Heller, E. J. (Chicago Univ., Ill. (USA)). Chem. Phys. Lett.; 34: No. 2, 321-325(15 Jul 1975).

The "quantum trajectory" wavepacket approach to semiclassical collision dynamics is generalized to include effects which cause distortion of initially gaussian wavepackets. The generalization takes the form of a discrete phase space path "integral" or sum. A complete set of gaussian phase space localized basis functions is proposed, and in the semiclassical limit, each basis function time develops in a simple classical-like fashion. Thus, the formulation conveniently builds in the correct limiting semiclassical behavior. The phase space path sum is formally exact, numerically it appears convenient, and is apparently equally at home in quantum and semiclassical regimes. (auth)

**30013** LINKED-CLUSTER EXPANSIONS IN THE EQUATIONS OF MOTION METHOD FOR NONEQUILIBRIUM PROCESSES. Der, R.; Haberlandt, R. (Akademie der Wissenschaften der DDR, Leipzig. Zentralinstitut fuer Isotopen- und Strahlenforschung). Physica; 79: No. 6, 597-616(1975).

For an arbitrary irreversible process taking place in a closed physical system equations of motion are derived directly from the Liouville equation without introducing any projection operator. These equations are of nonmarkovian nature and are exactly valid for any system arbitrarily far from equilibrium. Using field-theoretical techniques the integral kernels in these equations are expanded into a diagram perturbation series which is proved to be linked. For a system having short memory it is shown that the secular divergent terms cancel each other. Then, using the diagram language the equations of motion are obtained in a much simpler form. (auth)

**30014** EXACT SOLUTION OF THE CLASSICAL AND QUANTAL ONE-DIMENSIONAL MANY-BODY PROBLEMS WITH THE TWO-BODY POTENTIAL $v_a(x) = g^2a^2/\sinh^2(ax)$. Calogero, P. (Univ., Rome); Ragnisco, O.; Marchioro, C. (Univ., Rome). Lett. Nuovo Cim.; 13: No. 10, 383-387(5 Jul 1975).

The one-dimensional problem of N equals particles interacting pairwise via the potential $v(x) = g^2a^2\sinh^2(ax)$ is considered. It

is shown, in both classical and quantal cases, than an initial state characterized by asymptotic incoming momenta $p_j$ goes uniquely over into a find state of asymptotic outgoing momenta $p_{N-j-1}$. (SDF)

## Quantum Field Theories

*Refer also to abstracts 29350, 29472, 29565, 29571, 29894, 29952, 30094, and 30096.*

**30015** (ITP-75-34P) EQUIVALENCE THEOREM AND RENORMALIZATION THEORY. Rutenberg, M. L. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1975. 21p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

The renormalization of the physical constants is studied in the S-matrices corresponding to Lagrangian densities which are connected by local field transformation. (auth)

**30016** (JINR-P2-8986) POSSIBLE ELEMENTARY PROCESSES WITH FASTER-THAN-LIGHT VELOCITIES. Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1975. 20p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The consequences are considered of the hypothesis about the existence in the nature of the signal velocities higher than that of light in vacuum. In macroscopic phenomena such signals lead to acausal effects. However, it is not out of the question that the faster-than-light signals can be in very small space-time regions, where the processes with T-parity violation are of great importance. (auth)

**30017** (JINR-R-2-8210) ON SUPERGAUGE TRANSFORMATIONS OF FIELDS. Nguen Van Kh'eu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 12p. (In Russian). INIS.

Supergauge transformations of fields were studied. Detailed examination of transformation laws for the components of the scalar superfield resulted in finding of five supergauge multiplets. One of these may also be obtained from the spinor superfield. Among the five supergauge multiplets, only one satisfies the material equation. (tr-auth)

**30018** (JINR-R-2-8242) CONFORMAL PROPERTIES OF BILOCAL FIELDS. Zajkov, R. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 12p. (In Russian). INIS.

The law of conformal transformation of bilocal fields was studied. A representation of two-point functions of such fields was obtained in the form of an expansion on two-point functions of basic tensor fields. (tr-auth)

**30019** (LBL-3836) DUALITY PROPERTY FOR A HERMITIAN SCALAR FIELD. Bisognano, J. J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 28 Apr 1975. Contract W-7405-ENG-48. 49p. Dep. NTIS $5.50.

Thesis.

A general hermitian scalar Wightman field is considered. On the Hilbert space of physical states "natural" domains for certain complex Lorentz transformations are constructed, and a theorem relating these transformations to the TCP symmetry is stated and proved. Under the additional assumption that the field is "locally" essentially self-adjoint, duality is considered for the algebras generated by spectral projections of smeared fields. For a class of unbounded regions duality is proved, and for certain bounded regions "local" extensions of the algebras are constructed which satisfy duality. The relationship of the arguments presented to the Tomita–Takesaki theory of modular Hilbert algebras is discussed. A separate analysis for the free field is also given. (auth)

**30020** (ORO-225) FAILURE OF THE USUAL GAUGE FORMALISM IN A CLASS OF GAUGE CONDITIONS. Hsu, J. P.; Mac, E.; Sudarshan, E. C. G. (Texas Univ., Austin (USA). Center for Particle Theory). Oct 1975. 13p. Dep. NTIS $4.00.

For a class of gauge conditions the usual formalism for non-Abelian gauge theories leads to violation of unitarity. In contrast, the Lagrange multiplier formalism allows one to construct an adequate fictitious Lagrangian. The theory so obtained satisfies unitarity. (auth)

**30021** DYNAMIC SPONTANEOUS VIOLATION OF GAUGE INVARIANCE IN ASYMPTOTICALLY FREE THEORIES. Ansel'm, A. A.; D'yakonov, D. I. (Leningrad Inst. of Nuclear Physics). Zh. Eksp. Teor. Fiz.; 68: No. 5, 1614-1634(May 1975). (In Russian).

The mechanism of dynamical spontaneous breaking of gauge invariance suggested by Coleman and Weinberg. In this mechanism scalar fields acquire nonzero vacuum expectation values due to quantum effects. With the help of renormalization group technique one studies scalar electrodynamics and gauge theories of the Yang–Mills type. It is found for the latter that it is possible to conciliate the dynamical symmetry breaking with the asymptotic freedom of the theory, provided the coupling constants are appropriately chosen. The occurrence of symmetry breaking turns out to be closely associated with the existence of infrared poles in coupling constants in the asymptotically free theories. The arising masses of vector mesons automatically screen these undesirable poles. It is shown that the physical results are independent (at least to the first nontrivial order of perturbation expansion) of the initial gauge of the vector fields. (auth)

**30022** NORMAL PRODUCTS IN DIMENSIONAL REGULARIZATION. Collins, J. C. (Cambridge Univ. (UK). Dept. of Applied Mathematics and Theoretical Physics). Nucl. Phys., B.: 92: No. 3, 477-506(7 Jul 1975).

It is shown how to reformulate Zimmermann's normal product method for quantum field theory using dimensional regularization. The finite part operation used is defined by the subtraction of pole parts of diagrams (and subdiagrams) at the physical space-time dimension n = 4. When applied to spontaneous symmetry breaking (SSB), at least of the Nambu-Goldstone type, the original method has complications caused by non-linearity in the Bogoliubov finite-part operation. It is shown how the method avoids such problems, the subtractions being always minimal. SSB is treated almost as easily as in the tree approximation, e.g. when proving Ward identities. Similar simplification should occur for gauge theories, though this is not demonstrated in this paper. The minimality of the subtractions means that anisotropic and over-subtracted normal products are not defined in the new method. Finally, certain properties of n-dimensional Feynman integrals are proved; the use of analytic regularization in rigorous proofs of Ward identities etc. is thus avoided. (auth)

**30023** GROUP-STRUCTURE OF THEORIES IN THE INFINITE MOMENTUM FRAME. Toth, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Nucl. Phys., B.; 92: No. 3, 524-540(7 Jul 1975).

It is widely believed, that there is a correspondence between infinite momentum frame physics and two-dimensional Galilean physics. This is usually demonstrated by arguing that Weinberg's rule for the old-fashioned perturbation series in the infinite momentum limit can be interpreted as a perturbation series in a two-dimensional Galilean theory. In order to find for this a basis more solid than the usual heuristic arguments, a systematic investigation of the group structure of interacting scalar field theory is performed. It turns out, that the above mentioned correspondence is not necessary. There is a one-parameter freedom in determining the group-structure of the theory in the infinite momentum frame. This parameter has a similar meaning to the velocity of light: when it is finite, one has a relativistic theory, when it is infinite, one has a Galilean theory. It is shown, that Weinberg's above rule may equally well be interpreted as a "non-covariant perturbation series" in a two-dimensional relativistic theory. Possibilities to make use of the two-dimensional relativistic scheme are also discussed. (auth)

**30024** ELECTROMAGNETIC THEORY TREATED IN ANALOGY TO THE THEORY OF GRAVITATION. Klein, O. Nucl. Phys., B.; 92: No. 3, 541-546(7 Jul 1975).

As a further contribution to the program of Klein the present paper treats electromagnetic theory as an analog to that of gravitation, introducing two extra dimensions not belonging to space and time, one space-like and one time-like. The difficulty concerning unitarity mentioned there is surmounted by a rational generalization of Bargmann's a needed for the same purpose for the Lagrangian density belonging to the Dirac equation. Moreover, the treatment of the inversion relations, using one extra dimension, is extended to two such dimensions. These two dimensions lead to the possibility of a natural avoidance of the difficulty present in the so-called five-dimensional representation of electromagnetism of an enormously large mass term, at least for states of so-far known masses. Finally, these two dimensions lead to the introduction of two sets of electromagnetic potentials corresponding to the equations given by Schwinger in developing Dirac's idea of magnetic monopoles, obtaining thereby a further background. It should be stressed that what has been said here about particle states belongs to the primary empty particles without normalization. Hence it is probably premature yet to try to explain these most interesting symmetries, which belong to "non-empty" states. (auth)

**30025** CLASSICAL PARADOXES FOR ORTHODOX VALUES: THE THEOREMS OF EINSTEIN, PODOLSKY, ROSEN, AND OF BELL. de la Pena, L.; Cetto, A. M. (Inst. of Physics, Mexico City). Rev. Mex. Fis., Supl. Ensenanza; 23: E39-E48(1974). (In Spanish).

The theorems of Einstein, Podolsky and Rosen and of Bell are briefly analyzed; it is shown that the paradoxical content that is frequently attributed to them arises in the last instance

from the underlying epistemological postulates. In particular, it is concluded that from the point of view of these theorems the statistical interpretation of quantum mechanics is perfectly consistent and legitimate and moreover, that it offers the advantage over the orthodox interpretation of being free from paradoxical aspects. (auth)

**30026** DERIVATION OF THE SLAVNOV–TAYLOR–'T HOOFT IDENTITIES. van der Kolk, C. M. (Amsterdam Univ. (Netherlands). Instituut voor Theoretische Fysica). Phys. Lett., B.; 57: No. 2, 165-168(23 Jun 1975).

Using a special Bell-Treiman transformation, a simple proof of the Slavnov–Taylor–'t Hooft identities is given. (auth)

**30027** ANGULAR MOMENTUM AND DISCRETE SYMMETRIES IN THE SPINOR BETHE-SALPETER EQUATION. Bauhoff, W. (Tuebingen Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Z. Nautrforsch., a; 30: No. 4, 395-401(Apr 1975).

The group-theoretical basis for the angular momentum reduction of the spinor Bethe-Salpeter equation is discussed. Amplitudes of definite angular momentum are constructed by analogy to the nonrelativistic problem and differences are discussed. The additional decomposition because of discrete symmetries is explained. Finally, the states are related to those obtained in the nonrelativistic quark model. (auth)

**30028** MAXWELL'S EQUATIONS IN THE ELECTRODYNAMICS OF MOVING BODIES. Viviani, A.; Viviani, R. (Facolta di Ingegneria, Genoa). Nuovo Cim., B; 28B: No. 1, 191-224(11 Jul 1975).

The electromagnetic field of a point charge moving in free space at velocity u and acceleration a is evaluated on the basis of Maxwell's equations, and an approximation of this field is made for nonrelativistic velocities. Some differences result between the approximate formulas and the analogous relations that can be found in the literature. Under the hypothesis that the fields of more complex systems can be obtained by means of the superposition of the fields of the various point charges present in these systems, and under other less important hypotheses, the form of the field equations in systems with moving charge carriers is calculated. It results that Maxwell's equations seem to be valid in an inertial frame for systems in which only "metallic type" conductors carry considerable currents, and when only very slow body motions are involved. If moving bodies, or current in "nonmetallic type" conductors, are involved, other equations must be used, whose form is proposed. In such equations the extra terms not contained in Maxwell's equations represent fields depending on the square of the particle velocity, and cannot be obtained by the magnetic field, which produces only linear terms, except for the Lorentz field. Nay, such extra terms can in part be considered as an extension of the Lorentz field. The proposed equations seem to overcome some contradictions present in the literature, regarding the relativistic invariance of the charge and some simple examples of fields with moving bodies. The fields that Maxwell's equations do not take into account are not negligible with respect to Lorentz fields, which, in similar cases, are commonly considered significant. (auth)

**30029** RELATIVISTIC VERSION OF THE $1/q^2$-THEOREM BY N. N. BOGOLYUBOV. Kazanskii, A. K. (Leningrad State Univ.). Teor. Mat. Fiz.; 22: No. 3, 418-421(Mar 1975). (In Russian).

The $1/q^2$-theorem by N. N. Bogolyubov is generalized for relativistic field model with spontaneously broken symmetry. (auth)

**30030** STABILITY OF INTERACTION BY MEANS OF THE RENORMALIZATION GROUP METHOD. Bazhanov, V. V.; Pron'ko, G. P. (Inst. of High Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 24: No. 1, 11-16(Jul 1975). (In Russian).

By means of the renormalization group method the stability of various kinds of interactions with respect to spontaneous production of nonzero vacuum expectation of the scalar field was investigated. (auth)

**30031** RELATIVISTIC FORM FACTORS OF COMPOSITE SYSTEMS. Garsevanishvili, V. R.; Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 24: No. 1, 3-10(Jul 1975). (In Russian).

The "light-front" formulation of the quasi-potential approach in quantum field theory is applied to constructing the relativistic formfactors of many-body composite systems. (auth)

**30032** INVARIANT THEORETIC DERIVATION OF THE CONNECTION BETWEEN MOMENTUM AND VELOCITY. Ahmad, S. M. W.; Wigner, E. P. (Princeton Univ., NJ). Nuovo Cim., A; 28A: No. 1, 1-11(1 Jul 1975).

The significance of the energy-momentum conservation laws, as consequences of the general invariance principles, is much enhanced if the momentum, and hence the energy, can be coupled, still by means of the invariance principles, to some directly observable quantity. If the positions of particles can be measured in the quantum-mechanical sense, and if the corresponding operator satisfies the obvious invariance requirements, the velocity can also be ascertained and its relation to the momentum four-vector can easily be derived from the displacement invariances. Serious doubts have been cast, however, on the measurability of the position. Hence, a more primitive method of measuring the velocity, by means of traps is described; it is essentially the experimental methcd. The connection between momentum and velocity is then derived, for the velocity measured in this way, from the displacement invariance principle. (auth)

**30033** HIGHER ORDER DERIVATIVE THEORIES AND CONFORMAL INVARIANCE. Chiang, C. C.; Duerr, H. P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., A; 28A: No. 1, 89-113(1 Jul 1975).

In generalization of an earlier result by Dürr and van der Merwe it is demonstrated that the massless $(N + 1)$-order Klein-Gordon equations for a scalar field and the $(2N + 1)$-order Weyl and Dirac equations for a spinor field are invariant under conformal transformations if one attributes a (mass) dimension $1 - N$ to the scalar field and a dimension $\frac{1}{2} - N$ to the spinor field. For $N > 0$ the canonical quantization of these field theories requires a vector space with indefinite metric. The state spaces in the occupation number representation are explicitly given. They can be constructed in such a way that, in addition to normalizable states occurring for $N =$ even in the scalar case and in all spinor cases, the states can be grouped into pairs of nonorthogonal zero-norm states. The Hilbert subspace spanned by the normalizable states which are eigenstates of the Hamiltonian can be taken as the physical subspace. The current operator is constructed in the spinor cases. One shows that the conformal invariance of the gauge-invariant current operator for $N > 1$ can only be achieved if the gauge field is not an independent field but is built up from the spinor field in a particular fashion which generalizes an earlier conjecture by Dürr and Winter. Higher-order derivative theories allow interactions which increase with distance and hence are of physical interest in connection with the confinement and the ultraviolet divergence problem. (auth)

**30034** RENORMALIZABLE THEORY OF LEPTONS WITH INTRINSIC SYMMETRY BREAK-DOWN. Hsu, J. P.; Sudarshan, E. C. G. (Univ. of Texas, Austin). Lett. Nuovo Cim.; 13: No 15, 557-560(9 Aug 1975).

A renormalizable unified theory of weak and electromagnetic interactions for leptons is constructed involving a massless scalar boson and very weak coupling. To check the consistency of the theory with experiment, the anomalous quadrupole moment of the vector particle W at rest, and the anomalous magnetic moment of the electron are calculated. The results are equivalent to those of Weinberg theory with $m_\phi = 0$. It is also pointed out that the theory involves no genuine infrared divergence. (SDF)

**30035** ELECTROMAGNETIC-MASS RELATIONS OF MESONS IN QUARTET MODEL BY CURRENT COMMUTATORS. Bose, S. K. (Univ., Kaiserslautern, Ger.). Lett. Nuovo Cim.; 13: No. 15, 568-574(9 Aug 1975).

Relations are found between electromagnetic masses of pseudoscalar mesons when they belong to the 1 + 15 irreducible representation of $SU_4$. Commutation relations of $SU_4$ are used in conjunction with free field equations and the canonical equal time commutation relations between fields and their conjugate momenta. Relations may be obtained in the same manner for vector meson masses. (SDF)

**30036** VECTOR-MESON MASSES IN BROKEN CHIRAL $SU_4 \times SU_4$ SYMMETRY. Bose, S. K. (Univ., Kaiserslautern, Ger.). Lett. Nuovo Cim.; 13: No. 15, 575-578(9 Aug 1975).

The mass spectrum of vector and axial vector mesons is studied within the framework of nonlinear $SU_4 \times SU_4$ chiral dynamics, with massive quarks obtained by transforming the quark field by Weinber's prescription. The meson masses derived are found to be close to their experimental values. (SDF)

**30037** CONSTITUENT'S FORM FACTORS AND THE LOGARITHMIC VIOLATION OF BJORKEN SCALING. Harada, K. (Tohoku Univ., Sendai). Lett. Nuvov Cim.; 13: No. 15, 579-585(9 Aug 1975).

In asymptotically free gauge theories, the fixed $Q^2$ moments of the structure function have been predicted to show logarithmic deviations from exact Bjorken scaling. The extent to which this logarithmic violation can be interpreted as an effect of the constituent's structure is examined. It is assumed that the

constituents are spin-1/2 quarks and can be described by an asymptotically free Lagrangian. The effect of the form factors on deep inelastic electroproduction, especially on the Bjorken scaling of $\nu W_2$ is considered. (SDF)

**30038** COVARIANT HAMILTONIAN FORMALISM FOR QUANTIZED FIELDS AND THE HYDROGEN MASS LEVELS. Enatsu, H.; Kawaguchi, S. (Ritsumeikan Univ., Kyoto). Nuovo Cim., A; 27A: No. 4, 458-481(21 Jul 1975).

A covariant Hamiltonian formalism in quantum field theory is used as the basis on which the quantization of the hydrogen mass is carried out; the mass levels of the hydrogen atom are computed. The chief results obtained are the nuclear corrections to the hyperfine mass levels of hydrogen: the reduced mass, Breit's relativistic and recoil corrections. An explanation of the parity mixing in the fine-structure levels is also proposed. (auth)

**30039** CROSSING RELATIONS DERIVED FROM (EXTENDED) RELATIVITY. Mignani, R.; Recami, E. (Catania Univ., Italy). Int. J. Theor. Phys.; 12: No. 5, 299-320(Apr 1975).

Recently, special relativity has been straightforwardly extended to superluminal inertial frames and faster-than-light objects. The "extended relativity" theory not only allowed building up a self-consistent "classical theory" of tachyons, but reveals itself useful also for the understanding of standard (subluminal) physics, i.e. of usual particles. It is shown that extended relativity allows: deriving the usual "crossing relations" of elementary particle (high energy) physics; and deriving the CPT-covariance theorem as a particular case of G-covariance (i.e., covariance under the new group of generalized Lorentz transformations, both subluminal and superluminal). In this framework, the "analyticity" postulate is unnecessary: it is better substituted by the G-covariance requirement. Moreover, new "crossing-type" relations are predicted on the basis of mere extended relativity. They may well serve as a test for relativistic covariance of "force fields" like strong interactions and, particularly, weak interactions, and possible new "interaction fields" (which a priori are not relativistically covariant). (auth)

**30040** FURTHER LINK(S) WITH INEQUIVALENT REPRESENTATIONS IN QUANTUM FIELD THEORY. Benson, A. K. (Indiana Univ. Southeast, New Albany). Int. J. Theor. Phys.; 12: No. 5, 321-332(Apr 1975).

In recent years it has become more apparent how useful inequivalent representations of the canonical commutation and anticommutation relations (CCR and CAR) in quantum field theory may be in describing and explaining physical phenomena, and several properties and concepts were stated, referred to, and/or developed in the literature on these ideas. Some of these are reviewed, and some further properties and concepts are developed as further links in understanding these inequivalent representations in quantum field theory. One of these is a statement as to what actually breaks down in some field theories in the transformation between representations which are unitarily inequivalent. This is developed using the language and ideas of point quantum mechanical invariance, since this should be more familiar to a much larger number of physicists. Also, a statement on state expectation values is developed which can be used as a criterion for the occurrence of inequivalent representations of the CCR and CAR in field theories. (auth)

**30041** TEACHING SPECIAL RELATIVITY. Ziggelaar, A. (Royal Danish School of Educational Studies, Copenhagen). Phys. Educ.; 10: No. 5, 361-363(Jul 1975).

Much introductory teaching of special relativity still follows traditional lines - basically following the historical evolution of relativity. An introductory course is described in which an explicit derivation of newtonian mechanics as a particular case of special relativity precedes the teaching of the fundamentals of newtonian mechanics. The course, consisting of sections covering relativistic kinematics, derivation of the Lorentz transformation, relativistic dynamics, transition to newtonian dynamics, and waves, is outlined. (UK)

**30042** UNIFIED FREE QUANTUM FIELDS FOR MASSIVE AND FOR MASSLESS PARTICLES. Mutze, U. (Univ., Munich). Fortschr. Phys.; 23: No. 2, 113-131(1975).

For any mass $m \geq 0$ and arbitrary spin, free relativistic quantum fields are constructed using the same formulas for $m > 0$ and for $m = 0$. The transformation properties of these fields under P, C, T and some questions concerning superselection rules are discussed. (auth)

**30043** SUPERFIELDS WITH INTERNAL SYMMETRY. Dondi, P. H. (Univ., Karlsruhe, Ger.). J. Phys., A (London); 8: No. 8, 1298-1309(Aug 1975).

The generalization of superfields to include an internal SU(n) symmetry group is studied, and shown to be a simple extension of the original formulation of Ferrara, Wess and Zumino (Phys. Lett.; 51B: 239 (1974)). (auth)

**30044** INTERPRETATION OF THE THEORY OF RELATIVITY. Nuthakki, P. (Andhra Univ., Waltair, India). Int. J. Theor. Phys.; 13: No. 1, 27-35(May 1975).

The presently accepted interpretation of the (special) theory of relativity is considered to be inadequate in certain respects. An alternative interpretation is suggested. (auth)

**30045** ABOUT THE RELATION [X, P] = i. Laue, H. (Calgary Univ., Alberta). Int. J. Theor. Phys.; 12: No. 5, 293-298 (Apr 1975).

By means of an example it is illustrated that the usual canonical commutation relation is not equivalent to the canonical commutation relation in the Weyl form. The example is also used to show that several well known operator identities are false because they were derived by formal power series expansions. (auth)

**30046** NAMBU MECHANICS AS A CLASS OF SINGULAR GENERALIZED DYNAMICAL FORMALISMS. Ruggeri, G. J. (Universidad Central de Venezuela, Caracas). Int. J. Theor. Phys.; 12: No. 5, 287-292(Apr 1975).

In a recent work Nambu (Physical Review; D7: 2405 (1973)) has proposed a c-number dynamical formalism which can allow an odd number n of canonical variables. Naturally associated to this new mechanics there exists an n-linear bracket whose study opens interesting possibilities. The purpose is to show that besides this bracket another one which is bi-linear and in fact a Lie bracket can also be associated with the Nambu mechanics. For any n, however, this bracket is singular. In a sense previously used this result exhibits the Nambu mechanics as an interesting class of singular generalized dynamical formalisms irrespective of the number of phase space variables. Reasons are given suggesting that such singular formalisms would be, within the present context, the only ones capable of describing classical analogs of generalized quantum systems. (auth)

**30047** SOFT PARAMETRIZATION OF RENORMALIZED FIELD THEORY AND KADANOFF SCALING. Jegerlehner, F. (Inst. for Theoretical Physics, Berlin). Fortschr. Phys.; 23: No. 2, 71-111(1975).

The soft renormalization procedure, proposed by GOMES, LOWENSTEIN and ZIMMERMANN, is applied to the construction of a pre-scaling (soft) parametrization of renormalized perturbation theory. The global pre-scaling parameters are directly incorporated into the Lagrangian; resummation problems and subsidiary condition are completely avoided. For the $A^4$-theory with linear symmetry breaking and the spontaneous limit a detailed structural investigation is given in terms of partial differential equations to all orders of perturbation theory. The scaling structure and "marginal" corrections to scaling are reconsidered in terms of the soft parametrization. The pre-scaling parametrization represents a powerful tool in dealing with the field theoretical aspects of critical phenomena. (auth)

**30048** SPINOR-SPINOR BETHE-SALPETER EQUATIONS WITH VECTOR AND AXIAL-VECTOR GLUONS. Ladanyi, K. (Roland Eotvos Univ., Budapest). Phys. Rev., D; 11: No. 8, 2320-2329(15 Apr 1975).

Wick-rotated spinor-spinor Bethe-Salpeter equations are investigated for systems bound to zero total mass by the exchange of vector and axial-vector gluons. At small relative coordinates, the interaction is assumed to be dominated by vector propagators which are chosen in a form suggested by theories of spontaneously broken gauge symmetries. Short-distance expansions are studied for the solutions belonging to representations $(\frac{1}{2}N, \frac{1}{2}N)$ of O(4). Particular attention is paid to the boundary conditions in order to formulate a well defined eigenvalue problem. All solutions of the indicial equations are explicitly given for arbitrary values of N; the indices involve the coupling parameters characterizing the short-distance behavior of the interaction. (auth)

**30049** CHARACTERIZATION OF CLUSTERING STATES. Robinson, D. W. (Aix-Marseille-2 Univ., 13-Marseille (France). Dept. de Physique). Commun. Math. Phys.; 41: No. 1, 79-88 (Mar 1975).

A characterization of states, over quasi-local algebras, which satisfy a strong cluster property is derived. The discussion is applicable to classical systems and quantum systems with Bose or Fermi statistics. (auth)

**30050** DERIVATION OF A CONDITION ON THE MOTION OF TWO DEFORMABLE BODIES. Tokis, J. N. (Department of Mechanics, University of Patras, Greece). Astrophys. Space Sci.; 35: No. 1, L27-L32(Jun 1975).

The conditions are derived for which the motion of a system of two deformable (fluid or not) bodies can be reduced to the well-

known two-body problem. The new condition is discussed for some pairs of such bodies existing in the natural world. (auth)

**30051** SPECTRAL PROPERTY OF TIME DELAY. Tsang, T. Y.; Osborn, T. A. (Brooklyn Coll., N. Y. (USA)). Nucl. Phys., A; 247: No. 1, 43-50(28 Jul 1975).

This paper discusses the spectral property of time delay. If one considers the scattering by a potential v, then the spectral property is the statement that the trace of the time-delay operator is proportional to the change in state density produced by the interaction v. A new and elementary proof of this result is given. As a consequence it is shown that Levinson's theorem is implied by the spectral property. (auth)

**30052** EIGENFUNCTIONS AND EIGENVALUES OF THE WIGNER OPERATOR. Jannussis, A.; Patargias, N. (Dept. of Theoretical Physics, University of Patras, Patras, Greece). Phys. Lett., A; 53: No. 5, 357-358(14 Jul 1975).

It can be proved that the Wigner operator, which results from the quantum-mechanical foundation of Bopp, accepts as eigenvalues the differences of the eigenvalues of two equivalent Schroedinger equations. The eigenfunctions result with the help of a Fourier transform in the phase space of the corresponding eigenfunctions of the Schroedinger equations. (auth)

**30053** SOLITON SOLUTIONS OF THE MASSIVE THIRRING MODEL. Orfanidis, S. J.; Wang, R. (New York Univ., N. Y. (USA). Dept. of Physics). Phys. Lett., B; 57: No. 3, 281-283 (7 Jul 1975).

The one-soliton solutions of the Sine–Gordon equation are used to construct exact classical solutions of the massive Thirring model. They explicitly realize the correspondence suggested by Coleman for the two quantum theories. Their uniqueness and stability properties are discussed. (auth)

**30054** INFINITE MOMENTUM FRAME METHOD IN FIELD THEORY WITH SOME APPLICATIONS. van Neerven, W. L. G. A. M. Nijmegen, Netherlands; Katholieke Universiteit Nijmegen (1975). 216p.

Thesis.

An outline is given of the infinite momentum frame (I.M.F.) method in renormalizable field theories, which is based on time-ordered perturbation theory. The method is applied to calculate radiative corrections to the anomalous magnetic moment of the electron and the muon. An introduction is given to the parton model, which is then applied to deep inelastic electroproduction $e + p \rightarrow e +$ anything. From experiments on this reaction it is found that the structure functions scale. The parton model is also applied to massive muon pair production $p + p \rightarrow \mu^+\mu^- +$ anything, and in this case the infinite momentum itself appears as a scaling variable. I.M.F. techniques are used to calculate the anomalous thresholds which appear in the amplitudes of hadron–hadron scattering. (NL)

**30055** PROBLEM OF GENERALIZED SINGULAR FUNCTION PRODUCT IN QUANTUM FIELD THEORY IN DE-SITTER MOMENTUM SPACE. Donkov, A. D.; Kadyshevskii, V. G.; Mateev, M. D.; Mir-Kasimov, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Bulg. J. Phys.; 11: No. 1, 3-9(1975). (In Russian).

It is shown that commutators, propagators and other quantities which are considered in conventional local quantum field theory as generalized functions, can be treated as ordinary functions for which the problem of taking a power and multiplying with each other does not exist if one passes to field theory with constant curvature p-space. This fact indicates a possible reduction, in the developed approach, of the difficulties connected with the ultraviolet divergences. (auth)

**30056** PROPOSALS FOR A BOOTSTRAP THEORY OF ELECTRODYNAMICS. van der Merwe, P. duT. (Atomic Energy Board, Pretoria). Lett. Nuovo Cim.; 13: No. 11, 417-421(12 Jul 1975).

An electromagnetic bootstrap is proposed in which the photon and the electromagnetic aspects of leptons are united under a single heading. The underlying scale invariance of the theory eliminates the metaphysical concept of bare mass, the masses being spontaneously generated by the break-down of scale invariance triggered by the particular infra-red features of the theory which themselves derive from the underlying scale invariance. This in turn results in new short-range effects which eliminate the (logarithmic) infinities of the fermion self-energy. The electromagnetic bootstrap is the expression of the self-consistency which is brought to light between the composite photon-lepton coupling and the lepton electromagnetic self-energy. The bootstrap is formulated in the framework of the Heisenberg unified theory of elementary particles. Although the self-consistency hinges on particular features of the unified theory such as its scale invariance, features of the indefinite metric and the concomitant infra-red aspects, it may well be that the existence of an electromagnetic bootstrap is of greater generality than the presentation might indicate. (auth)

**30057** SOME NEW NOTIONS CONCERNING LOCALITY AND NONLOCALITY IN THE QUANTUM THEORY. Baracca, A. (Univ., Florence); Bohm, D. J.; Hiley, B. J.; Stuart, A. E. G. Nuovo Cim.; 28B: No. 2, 453-466(11 Aug 1975).

One begins by developing in more detail the growing but largely implicit realization that Bell's theorem is, in essence, not a test for the existence of hidden variables but, rather, for whether or not the wave function of a many-body system tends to factorize into a product of localized states of its constituent particles. If such a process of spontaneous localization actually does take place, it cannot be treated in terms of Schroedinger's equation, but requires qualitatively new kinds of laws. A possible form of these laws is indicated briefly. It is shown further that such laws do not fit in with customary notions of dynamical causality but are rather examples of a different kind of relation that may be called formal causality. An analogy is given that helps to explain more fully what is meant by formal causality. The proposals are then presented concerning the parameters determining the conditions under which spontaneous localization will take place. It is suggested that these are related, not to the coherence length, but rather to a critical time $\tau_0 = \hbar/kT$, in which a system large enough to have thermal properties will undergo a change in quantum state. From the suggestion it follows that, in experimental investigations carried out thus far, one was looking for the process of spontaneous localization in the wrong place. Some indications of what may be the right place to look for this process are given. Finally, it is pointed out that the notion of spontaneous localization makes it unnecessary to give the measuring apparatus a fundamental role in the theory so that the measurement problem of conventional quantum mechanics disappears. (auth)

**30058** DIRECT-ACTION ELECTRODYNAMICS AND MAGNETIC MONOPOLES. Tipler, F. J. (Univ. of Maryland, College Park). Nuovo Cim.; 28B: No. 2, 446-452(11 Aug 1975).

It is shown that direct-action electrodynamics cannot be generalized to include magnetic monopoles. Consequently, experimental searches for magnetic monopoles constitute a test of the theory. (auth)

**30059** HIGGS MECHANISM AND THE MASSLESS SPECTRUM OF THE FERMION IN THE SCHWINGER MODEL. Ito, K. R. (Kyoto Univ.). Lett. Nuovo Cim.; 13: No. 12, 449-452 (19 Jul 1975).

It is shown that the covariant version of the Higgs mechanism is responsible for the mass of the photon field in the Schwinger model. (SDF)

**30060** INVESTIGATION OF THE ROLE OF CONFORMAL COVARIANCE IN THE THEORY OF THE MASS-ZERO, SPIN-TWO FIELD. Knezovich, F. M. Birmingham, AL; Univ. of Alabama (1974). 98p. University Microfilms Order No. 75-9916.

Thesis (Ph. D.).

The previous work of Coulter on a description of the mass-zero, spin-two field is investigated and extended. Coulter's field equations are first compared with conventional mass-zero, spin-two field equations with sources, and it is found that the conventional theories all have sources with no spin-two content, and acquire extraneous spin components in the region of sources. A conformally covariant representation of the mass-zero, spin-two field in terms of a tensor potential is then given, and a general solution for the tensor potentials obtained in the case of a static, spherically-symmetric source distribution. The extent to which the tensor potential is determined by the field equations is investigated, and it is shown that there is at least one arbitrary function among the components of the potential. A conformally covariant Lagrangian for the mass-zero, spin-two field is written out and equations of motion and conserved quantities for the Lagrangian are calculated. Finally, some comments are offered regarding possible gravitational relevance of this conformally covariant mass-zero, spin-two theory. (Diss. Abstr. Int., B)

**30061** PART I. SOME ASPECTS OF THE S-WAVE FERMION-SCALAR BOUND STATE IN THE BETHE–SALPETER LADDER MODEL. Part II. Rotational Analyticity of the S-Matrix. Sterman, G. F. Baltimore; Univ. of Maryland (1974). 162p. University Microfilms Order No. 75-7366.

Thesis (Ph. D.).

An investigation of some aspects of the Bethe–Salpeter ladder model for the bound state of a fermion and a scalar particle exchanging a neutral scalar gluon is described. The asymptotic behavior of ladder diagrams in relevant limits is also calculated independently from perturbation theory, and results on the be-

havior of wave functions and the electromagnetic form factors are verified. It is shown that, at least in leading log summation in the crossed channel, the relevant asymptotic behaviors of the ladder diagrams derived in this connection survive in the wave function which appears in the residue of the bound state pole. Starting from known results of field theory, it is shown that both scattering and production amplitudes are analytic on the group SU(2). (JFP)

**30062** PHILOSOPHY OF QUANTUM MECHANICS. The Interpretations of Quantum Mechanics in Historical Perspective. Jammer, M. New York; John Wiley and Sons (1974). 547p. $19.95.

The topics covered are the early semiclassical interpretations, the indeterminancy relations, early versions of the complementarity interpretation, the Bohr–Einstein debate, the incompleteness objection and later versions of the complementarity interpretation, hidden-variable theories, quantum logic, stochastic and statistical interpretations, and theories of measurements. (JFP)

**30063** INFINITE VOLUME ASYMPTOTICS IN $P\phi_2$ FIELD THEORY. Lenard, A.; Newman, C. M. (Indiana Univ., Bloomington (USA). Dept. of Mathematics). Commun. Math. Phys.; 39: No. 3, 243-250(Dec 1974).

12 refs.

A number of asymptotic results in the $P\phi_2$ theory in the limit when the space cut-offs are removed, in particular the behavior of $E_1$ and $Z_{t,1}$ as t,l to infinity are discussed. Such results are used to study the question of orthogonality of infinite volume Euclidean measures for varying interaction constants. (auth)

**30064** WIGNER'S THEOREM ON SYMMETRIES IN INDEFINITE METRIC SPACES. Bracci, L.; Morchio, G.; Strocchi, F. (Scuola Normale Superiore, Pisa (Italy)). Commun. Math. Phys.; 41: No. 3, 289-299(Apr 1975).

26 refs.

The description of symmetries in indefinite metric spaces is investigated. It is shown that ray transformations preserving the modulus of an indefinite scalar product can be implemented by linear or antilinear vector transformations which are generalized unitary or antiunitary operators with respect to the indefinite scalar product. A number of interesting features arise since such operators need not to be bounded. (auth)

**30065** SEPARABILITY AND INVARIANCE PROPERTIES IN NON-RELATIVISTIC AND RELATIVISTIC QUANTUM MECHANICS. Sokolov, S. N. (Inst. of High Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 23: No. 3, 355-365(Jun 1975). (In Russian).

The relation between the separability properties of the movement transformation operators U(a) and the invariance and separability properties of the scattering operators S is considered for the case of arbitrary (continuous) movement group G. The notion of $\tau^{\nu}$-separability is introduced. It is shown that for groups G possessing an invariant abelian subgroup, containing the subgroup of evolution transformations $U_t$, and, in particular for the Galilei and Poincaré groups, the invariance of the operators S and their separability in time follow from the reasonably good ($\gamma > 1$) $\tau^{\nu}$-separability of the operators U(a). For the Galilei and Poincaré groups it is demonstrated that the separability of the operators S in space is the consequence of their separability in time. It is shown that the choice of relative spatial variables, which is not unique in the relativistic case, does not influence the properties of spatial separability. (auth)

**30066** OPERATOR REALIZATION OF GENERALIZED PAULI-VILLARS REGULARIZATION. Slavnov, D. A. (Moscow State Univ.). Teor. Mat. Fiz.; 23: No. 3, 322-330(Jun 1975). (In Russian).

Vector space of "quasistates" is constructed, in which the notion of "field operator at fixed point" can be determined. The usual and chronological products of "fields at fixed point" are defined as operators in this space. In the space of quasistates there is a subspace of "regular quasistates", which can be provided with a norm and scalar product. When the factorization over this norm is performed, the space of regular quasi-states acquires the structure of the usual Fock space of states. Reduction of operators corresponding to the usual and chronological products of the fields, from the space of quasistates to the subspace of regular quasistates generates operator-valued distributions in the Fock space. Thus the regularization procedure turns out to be incorporated intrinsically in the construction of the vector space. (auth)

**30067** CONNECTION BETWEEN AN EUCLIDEAN GAUSS MARKOV VECTOR FIELD AND THE REAL PROCA WIGHTMAN FIELD. Yao, T. H. (Bedford Coll., London (UK). Dept. of Mathematics). Commun. Math. Phys.; 41: No. 3, 267-271(Apr 1975).

3 refs.

An Euclidean Gauss Markov vector field is constructed which leads to the real Proca Wightman field describing particles of mass > 0 and spin 1, for space-time dimensions equal to 4. (auth)

**30068** GENERALIZED WKB METHOD IN THE THREE-DIMENSIONAL CASE. I. Zhirnov, N. I.; Nurlygayanov, F. B. (Moscow State Univ.). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 43-50(1975). (In Russian).

The possibility of applying the generalized WKB method to the study of the stationary state of one-particle systems in three-dimensional potential fields, not assuming a separation of variables in the Schroedinger equation, was examined. Approximation wave functions, converting into the known Van Horn wave functions in the quasi-classical case, were constructed. (tr-auth)

**30069** INDUCED REPRESENTATIONS AND FREE FIELD EQUATIONS. Grensing, G. (Kiel Univ. (F. R. Germany). Inst. fuer Reine und Angewandte Kernphysik). Z. Naturforsch., A; 30: No. 5, 583-593(May 1975).

25 refs.

A simple and genuine method is given for the derivation of free field equations. Within this approach the field equations represent necessary and sufficient conditions for the field representation to be a unitary and irreducible representation of a covering group of the full Poincare group. The method is applied to particles with spin less than or equal to one. (auth)

**30070** NUMERICAL SOLUTION OF THE SPINOR–SPINOR BETHE–SALPETER EQUATION IN FUNCTIONAL NONLINEAR SPINOR THEORY. Bauhoff, W. (Tuebingen Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Z. Naturforsch., A; 30: No. 5, 656-671(May 1975).

6 figs.; 3 tabs.; 30 refs.

The mass eigenvalue equation for mesons in nonlinear spinor theory is derived by functional methods. In second order it leads to a spinorial Bethe-Salpeter equation. This is solved by a variational method with high precision for arbitrary angular momentum. The results for scalar mesons show a shift of the first order results, obtained earlier. The agreement with experiment is improved thereby. An excited state corresponding to the eta' is found. A calculation of a Regge trajectory is included, too. (auth)

**30071** QUANTIZED FIELDS IN INTERACTION WITH EXTERNAL FIELDS. I. Exact Solutions and Perturbative Expansions. Bellissard, J. (Marseille Univ., 13 (France)). Commun. Math. Phys.; 41: No. 3, 235-266(Apr 1975).

2 figs.; 2 tabs.; 38 refs.

One considers a massive, charged, scalar quantized field interacting with an external classical field. Guided by renormalized perturbation theory it is shown that whenever the integral equations defining the Feynman or retarded or advanced interaction kernel possess nonperturbative solutions, there exists an S-operator which satisfies, up to a phase, the axioms of Bogoliubov, and is given for small external fields by a power series which converges on coherent states. Furthermore this construction is shown to be equivalent to the one based on the Yang-Kaellen-Feldman equation. This is a consequence of the relations between chronological and retarded Green's functions which are described in detail. (auth)

**30072** GENERAL CONCEPT OF QUANTIZATION. Berezin, F. A. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). Commun. Math. Phys.; 40: No. 2, 153-174(Feb 1975).

9 refs.

The general definition of quantization is proposed. As an example two classical systems are considered. For the first of them the phase space is a Lobachevskii plane, for the second one the two-dimensional sphere. (auth)

**30073** DYNAMIC PROPERTIES OF LIQUID $^3$He. Lovesey, S. W. (Institut Max von Laue-Paul Langevin, Grenoble, France). J. Phys., C (London); 8: No. 11, 1649-1659(7 Jan 1975).

The dynamic structure factor $S(q,\omega)$ appropriate to the interpretation of neutron scattering measurements on $^3$He is studied within two theories that together cover the range of wavevectors down to the Fermi wavevector $k_F$. Both theories express the dynamics in terms of the isothermal susceptibility $\chi(q)$ and the longitudinal frequency $\omega_1(q)$. These quantities are estimated from precise x-ray measurements and a Lennard–Jones potential. The position of the peak in $S(q,\omega)$ plotted against $\omega$ for a fixed wavevector, denoted by $\omega_q$, is shown from a large q theory to oscillate gently about the non-interacting limit $q^2/2m$. Below $q \sim 3\text{Å}^{-1}$ the weight in $S(q,\omega)$ shifts toward low frequencies. An intermediate q theory is used to investigate $\omega_q$ in the vicinity of the main peak in the static structure factor. $\omega_q$ passes through a minimum at $q = 1.75\text{Å}^{-1}$ where it has a value of some 0.4 meV. The magnitude, and to a lesser extent the position, of the minimum, is shown to be a sensitive function of the particle potential. Using

a Lennard–Jones potential with De Boer and Michels parameters a quantitative interpretation is obtained of preliminary neutron scattering data by Scherm. $S(q,\omega)$ does not show a narrow, intense peak indicative of a collective mode for $q \sim k_F$. (auth)

**30074** A MANIFESTLY GAUGE-INVARIANT FORMULATION OF QUANTUM ELECTRODYNAMICS. Balescu, R.; Poulain, M. (Brussels Univ. (Belgium). Faculte des Sciences). Physica; 79: No. 6, 559-568(1975).

A manifestly gauge-invariant formulation of quantum electrodynamics is constructed in which the basic dynamical variables are physically observable quantities. The theory is relativistically covariant, because the structure of the Poincaré group is built into it from the beginning. (auth)

**30075** PROBLEMY RELIATIVISTSKOI DINAMIKI MNOGIKH TEL I NELINEINOI TEORII POLIA. (Many-Body Problems of Relativistic Dynamics and Problems of Nonlinear Field Theory). Pisarenko, V. G. Kiev; Izdatel'stvo Naukova Dumka (1974). 463p.

A rigorous derivation of the equations of the external problem of n gravitating and electrically charged bodies is presented. Derived on the basis of the electromagnetic field equations of general relativity theory, the equations have the form of nonlinear differential equations with a deviating argument. The quantization of the relativistic problem of many bodies is examined. Nonlinear field equations that are covariant with respect to physical symmetry groups in Riemann spaces are analyzed, and methods for solving such equations are proposed. It is shown that these methods are applicable to a variety of nonlinear problems of general relativity, plasma physics, hydrodynamics, hydromechanics, and of the theory of wave processes in physically nonlinear media. (IAA)

**30076** QUASI-ISOTROPIC ASYMPTOTIC METHOD FOR ELECTROMAGNETIC WAVES IN MOVING MEDIA. Naida, O. N. Izv. Vyssh. Uchebn. Zaved., Radiofiz.; 17: No. 12, 1833-1850 (1974). (In Russian).

The geometrical equations analogous to quasi-isotropic approximation equations for rest media (Kravtsov equations) are built for a traveling electromagnetic wave in a moving inhomogeneous anisotropic medium with a weak birefringence. It is shown that in any case the full asymptotic series converges not farther than up to the terms having the order of amplitudes of waves scattered by the medium inhomogeneities. The method developed contains, as a partial case, a traditional Debye procedure. The procedure is applied to the case of moving inhomogeneous medium with dispersion (including strong birefringence). The constructed equations and the accuracy estimations admit the application of Schrödinger and Dirac equations, namely, to calculate (also by quasi-isotropic asymptotic method) the orientation of the magnetic moments of molecules, atoms, nuclei, electrons and other particles with spin moving in the variable magnetic field. These equations and estimations are equally applicable to the equations of elastic waves in anisotropic media. (auth)

**30077** ON A FINITE GAUGE-INVARIANT QUANTUM ELECTRODYNAMICS. Marioni, C. (Milan Univ. (Italy). Istituto di Scienze Fisiche). Nucl. Phys., B; 93: No. 3, 446-460(28 Jul 1975).

The Lee and Wick quantum electrodynamics (QED) is reformulated in a way that avoids all complications arising from the presence of complex singularities in the bare propagators. The theory is regularized by introducing an indefinite-metric (IM) space. Gauge invariance is achieved without any additional ad hoc prescription. The auxiliary fields entering the theory are shown to produce interactions of nonlocal nature, without sharing the physical particle properties. In this way the whole formalism obtains a very clear physical interpretation. (auth)

**30078** HIGH-ENERGY BEHAVIOUR IN $\phi^3$ THEORY IN SIX DIMENSIONS. Cardy, J. L. (California Univ., Santa Barbara (USA). Dept. of Physics). Nucl. Phys., B; 93: No. 3, 525-546 (28 Jul 1975).

The high energy behavior of $\phi^3$ theory is studied in six dimensions in both the Regge and deep inelastic limits, using the renormalization group and the Bethe-Salpeter equation. Both the case when the theory is asymptotically free, and the case when the ultraviolet behavior is controlled by a fixed point of the renormalization group, are considered. In the Regge limit, moving Regge poles are found in the first case, and a fixed square-root branch point in the second. In the deep inelastic limit, the results of the operator product expansion are confirmed, namely that Bjorken scaling of the moments of the structure function is broken by powers of $\ln Q^2$ and $Q^2$ respectively in the two cases. (auth)

**30079** PERTURBATION THEORY AND RENORMALIZATION OF SUPERSYMMETRIC YANG-MILLS THEORIES. Ferrara, S.; Piguet, O. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Phys., B; 93: No. 2, 261-302 (21 Jun 1975).

The problem of introducing, in supersymmetric Yang-Mills Lagrangians, a supersymmetric gauge breaking term and a Faddeev-Popov ghost interaction term is solved. The resulting Lagrangian turns out to be invariant under a global symmetry transformation which is the supersymmetric extension of the Slavnov symmetry. It is shown that the complete analysis of all primitively divergent supergraphs ensures, in conjunction with the Slavnov identities, the renormalizability of the theory, once a supersymmetric and gauge invariant regularizing procedure is introduced. It is found that the simplest regularizing procedure is a generalization of the higher covariant derivatives method. In the case of interaction with matter fields it is proved that no mass counter term is needed, in exact analogy with the model without gauge fields. Finally it is shown that, in the Abelian situation, a supersymmetric mass term for the vector multiplet can be introduced without spoiling the renormalizability, thus providing the supersymmetric extension of massive vector boson theories. (auth)

**30080** ON 't HOOFT'S RENORMALIZATION PROCEDURE IN GAUGE THEORIES. Banyai, L. (Academia R. S. R., Bucharest (Romania). Institutul de Fizica); Marculescu, S. (Bucharest Univ. (Romania)). Nucl. Phys., B; 93: No. 2, 355-364(21 Jun 1975).

Properties of renormalization constants (gauge dependence and the $\epsilon \to 0$ limit) are shown in 't Hooft's renormalization of Yang-Mills theories. The equivalence to a standard subtraction procedure is discussed at the one-loop level. (auth)

**30081** DIMENSIONAL REGULARIZATION OF MASSLESS THEORIES IN SPHERICAL SPACE-TIME. Drummond, I. T. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Phys., B; 94: No. 1, 115-144(4 Aug 1975).

The use of space-time curvature as an infrared cut-off was suggested for massless theories. The renormalization of massless theories in a spherical space-time (Euclidean version of de Sitter space) using dimensional regularization is investigated. Naive expectations are confirmed, namely that the coupling constant and wave-function renormalizations are independent of the curvature. Furthermore the curvature does not induce divergent mass terms or vacuum field values as would be possible on purely dimensional grounds. Although only scalar field theories were investigated, $\phi^4$ theory in four dimensions and $\phi^3$ theory in six, these results are encouraging for an application of the method to gauge theories. Formally massless theories are conformally invariant so the formulation of the theory in a spherical space ought to be equivalent to its formulation in flat space. In fact the renormalization procedure breaks conformal invariance and removes this equivalence. It is shown that to achieve the flat space limit it is necessary to invoke the aid of the renormalization group. Thus the zero curvature limit can be achieved for infrared stable theories ($\phi_4^4$) but not for infrared unstable theories ($\phi_2^3$) as might be expected. (auth)

**30082** CONFORMALLY-INVARIANT GREEN'S FUNCTIONS WITH THE CURRENT AND ENERGY-MOMENTUM TENSOR. Fradkin, E. S.; Palchik, M. Ya.; Zaikin, V. N. (AN SSSR, Moscow. Fizicheskij Inst.). Phys. Lett., B; 57: No. 4, 364-368(21 Jul 1975).

It is shown that within the conformally invariant theory the generalized Ward identities enable one to find explicit expressions for the vertex functions which possess arbitrary numbers of external lines corresponding to conserved operators (such as currents or the energy-momentum tensor). The transversal part of the above functions contains some arbitrariness which can be, though, fixed in the case of the two-dimensional space-time. These vertices, when found, give the possibility to extract experimental predictions from the hypothesis of conformal symmetry. They are also important quantities within the program of construction of the solutions of the renormalized field theory. (auth)

**30083** QUANTUM FIELD THEORY IN CURVED SPACETIME. DeWitt, B. S. (Texas Univ., Austin (USA). Dept. of Physics). Phys. Rep.; 19: No. 6, 295-357(Aug 1975).

54 refs.

Quantum field theory predicts a number of unusual physical effects in non-Minkowskian manifolds (flat or curved) that have no immediate analogs in Minkowski spacetime. The following examples are reviewed: (1) The Casimir effect; (2) Radiation from accelerating conductors; (3) Particle production in manifolds with horizons, including both stationary black holes and black holes formed by collapse. In the latter examples curvature couples directly to matter through the stress tensor and induces the creation of real particles. However, it also induces serious divergences in the vacuum stress. These divergences are analyzed, and methods for handling them are reviewed. (auth)

**30084** DYNAMICS OF A DOUBLE ROTATING SYSTEM OF BODIES IN A NEWTONIAN FORCE FIELD. Grobov, V. A.;

Siveniuk, V. V. (Kiev Higher Air Force Engineering-Aviation School). Prikl. Mekh.; 11: 55-63(Jan 1975). (In Russian).

The motion about the center of mass of a system composed of a platform carrying a rotor which rotates at a constant angular velocity is studied. It is assumed that the center of mass of the system moves along an elliptic orbit in a Newtonian gravitational field. A system of differential equations describing the behavior of parameters characterizing the orientation of the system in inertial space is derived, using a perturbation technique. Results obtained by numerical integration are examined. (IAA)

## Gravitation and General Relativity

*Refer also to abstracts 29464, 29465, and 30075.*

**30085** (CONF-730750-, pp J1-J13) PRESENT-DAY RESEARCH ON THE FOUNDATIONS OF THE GENERAL RELATIVITY THEORY. de Jongh, D. C. J. (Univ. of Pretoria). Nov 1973. (In Afrikaans).

From 8th annual seminar on theoretical physics; Pretoria, South Africa(9 Jul 1973).

In eighth annual seminar on theoretical physics.

A brief review is given of the principal theoretical and experimental research testing the validity of the general theory of relativity. (JSR)

**30086** (CONF-730750-, pp K1-K8) EVENT HORIZONS AND SINGULARITIES IN GENERAL RELATIVITY. du Plessis, J. J. (Univ. of Witwatersrand, Johannesburg). Nov 1973.

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

In Eighth annual seminar on theoretical physics.

Some aspects of the singularities predicted by the singularity theorem of Hawking and Penrose are pondered, in particular the Penrose conjecture that in the real world these singularities are generally hidden away in black holes and are thus invisible to people outside, so that the possible breakdown of general relativity near a singularity may not be so serious after all. (JFP)

**30087** BEHAVIOR OF ELECTROMAGNETIC CHARGES UNDER SUPERLUMINAL LORENTZ TRANSFORMATIONS. Coben, H. C.; Honig, E. (Univ. of Toronto). Lett. Nuovo Cim.; 13: No. 15, 586-588(9 Aug 1975).

By applying a superluminal transformation to the equation governing the dynamical behavior of ordinary subluminal electric charges, it is shown that the theory of tachyons requires that the character of the electric charge be retained upon passing from a subluminal to a superluminal frame and vice versa. The same is true for magnetic charges. (SDF)

**30088** EXTERNAL FIELDS OF COLLAPSED BODIES. Solodov, A. A. (All-Union Scientific Research Inst. of Meteorology, Moscow). Teor. Mat. Fiz.; 24: No. 1, 136-140(Jul 1975). (In Russian).

Static spherically symmetric solutions of the Einstein equations (without the cosmological term) and the Schroedinger-Fock-Klein (or Proca) equations with the massive scalar field $\varphi$ (or vector field $B_\mu$) in the central coordinate system with the interval $ds^2 = e^\nu dx^{0\,2} - e^\lambda dr^2 - r^2 d\Omega^2$ are investigated. It is shown that every solution $(\nu, \lambda, \varphi)$ (resp., $(\nu, \lambda, B_\mu)$) with asymptotically flat metrics and $\varphi \neq 0$ (resp., $B_\mu \neq 0$) is regular with respect to r in the interval $(0, \infty)$. (auth)

**30089** MANIFESTLY SCALE-INVARIANT SPACE-TIME CALCULUS. Klotz, F. S. (Trinity Coll., Dublin). Nuovo Cim., B; 28B: No. 1, 93-104(11 Jul 1975).

A tensor calculus that is manifestly invariant under conformal rescalings of the metric in an arbitrary space-time manifold is presented. The formalism is based on the local correspondence between conformal rescalings of the space-time manifold C with signature (+-----+). Simple C-tensor versions are constructed for the scale-invariant Brans-Dicke equations, the conformal Killing transport equations and the local twistor transport equations. The relations between C-tensors and local twistors is indicated, and a generalization of the local-twistor covariant derivative is obtained. (auth)

**30090** GAUGE THEORY IN THE EINSTEIN-CARTAN-WEYL SPACE-TIME. Kasuya, M. (Waseda Univ., Tokyo). Nuovo Cim., B; 28B: No. 1, 127-137(11 Jul 1975).

The field equations and the conservation laws in the Einstein-Cartan-Weyl space-time are obtained by postulating the invariance of a Lagrangian both under local Poincaré and local scale transformations. The results are rewritten in terms of field variables with gauge weight 0, and are compared with Kibble's ones. (auth)

**30091** SUPERPOSITION OF ELECTROMAGNETIC WAVES IN GENERAL RELATIVITY. Griffiths, J. B. (Loughborough Univ. of Tech., Eng.). Int. J. Theor. Phys.; 13: No. 1, 9-15 (May 1975).

It is shown that, in a region of space-time containing two independent electromagnetic waves propagating in different directions, it is not possible for the two waves to follow simultaneously affinely parameterized shear-free and twist-free null geodesic congruences. (auth)

**30092** BRANS-DICKE PLANE SYMMETRIC VACUUM. Tabensky, R.; Zamorano, N. (Univ. of Chile, Santiago). Int. J. Theor. Phys.; 13: No. 1, 1-8(May 1975).

The general solution of the mass zero scalar field coupled to the gravitational field with the assumption of plane symmetry is exhibited and partially interpreted. Energy transfer from a gravitational wave to test particles is studied invariantly. (auth)

**30093** ELECTROMAGNETIC WAVES FROM ANY ISOLATED SOURCE. Rotenberg, M. A. (Univ. of Wisconsin, Kenosha). J. Phys., A (London); 8: No. 8, 1200-1220(Aug 1975).

A double-parameter approximation method is applied to the Einstein-Maxwell equations of general relativity for the study of electromagnetic waves from any isolated cohesive source. It is found that, in general, the source undergoes secular changes of mass and angular momentum at rates equal and opposite to those at which energy and angular momentum are carried away by the waves from the source, as calculated by the electromagnetic energy tensor. (auth)

**30094** ANALYSIS OF BONNOR'S DIPOLE SOLUTION. Ward, J. P. (Queen Elizabeth Coll., London). Int. J. Theor. Phys.; 12: No. 5, 273-285(Apr 1975).

Some years ago Bonnor (Zeitschrift fur Physik: 190: 444 (1966)) presented a solution of the Einstein-Maxwell equations describing the field of a massive source carrying a magnetic dipole. An analysis of this solution is presented. Bonnor's solution is interesting because of its close connection to the Kerr solution and also because it is not a member of the Weyl electromagnetic class. (auth)

**30095** MINKOWSKI SPACE WITH ORDER TOPOLOGY IS SIMPLY CONNECTED. Nanda, S. (Regional Engineering Coll., Rourkela, India); Panda, H. K. Int. J. Theor. Phys.; 12: No. 6, 393-399(Apr 1975).

Among the large number of topologies which were suggested for Minkowski space, the order topology, i.e., the one generated by the positive cone at the origin and its translates, turns out to be most peculiar; yet it has some very pleasant properties. For example, it is pathwise connected and not arcwise connected, and every loop based at a point is homotopic to the constant loop at that point; in other words, Minkowski space with the order topology is simply connected. (auth)

**30096** ON THE ROLE OF WOOLLEY'S KILLING TENSOR IN EINSTEIN-MAXWELL THEORY. Ward, J. P. (Queen Elizabeth Coll., London). Int. J. Theor. Phys.; 12: No. 6, 345-348 (Apr 1975).

Wooley (Communications in Math. Phys.; 33: 135 (1973)) has recently discussed conditions (one of which requires that space-time admit a Killing vector) under which the energy-momentum tensor for an electromagnetic field can be expressed in a purely "geometric" form. It is shown that for the case when the required Killing vector is time-like, the only asymptotically flat solutions of Wooley's equations are members of the P. I. W. class recently discovered by Perjes and independently by Israel and Wilson (J. Math. Phys.; 13: 865 (1972)). This shows that although the work of Wooley exhibits a novel approach to Einstein-Maxwell theory, the usefulness of his results is much diminished. (auth)

**30097** NONSINGULAR GENERAL-RELATIVISTIC COSMOLOGIES. Bekenstein, J. D. (Univ. of Texas, Austin). Phys. Rev., D; 11: No. 8, 2072-2075(15 Apr 1975).

According to the "singularity theorems" of Penrose, Hawking, and Geroch, all general-relativistic cosmological models must have a singularity. However, the energy condition assumed by the theorems is not satisfied by all known forms of matter. (A notable exception is the massive Klein-Gordon field.) The object is to construct exact isotropic cosmological models without singularities by exploiting a violation of the energy condition which arises naturally from the basic physics, rather than being introduced ad hoc via an equation of state. This is accomplished with models in which the matter, envisaged as dust, interacts with a conformal scalar field whose field equation and stress-energy tensor come from an action principle. All the equations that govern the evolution of the models are solved exactly. For all possible topologies of the universe, the singularity can be avoided for a certain range of the parameters of the model, but only for the closed universe is the required range physically appealing. (auth)

**30098** STATIC FLUID SPHERES IN EINSTEIN–CARTAN THEORY. Prasanna, A. R. (International Center for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 11: No. 8, 2076-2082(15 Apr 1975).

Following the work of Trautman the Einstein–Cartan equations were described briefly with special reference to a perfect liquid distribution and then obtained three solutions adopting Hehl's approach and Tolman's technique. It was found that a space–time metric similar to the Schwarzschild solution (interior) will no longer represent a homogeneous fluid sphere in the presence of spin density, and the corresponding equation of state has the form 8 pi p equals 8 pi rho - $6/R^2 + (B_2/2$ pi A $R^2)$ (8 pi rho - $3/R^2)$/sup ½/, where R, $B_2$, and A are constants. At the boundary of the fluid sphere the hydrostatic pressure p is discontinuous. (auth)

**30099** KLEIN PARADOX IN A KERR GEOMETRY. Deruelle, N. (Princeton Univ., N. J. (USA). Joseph Henry Labs.); Ruffini, R. (Institute for Advanced Study, Princeton, N. J. (USA)). Phys. Lett., B; 57: No. 3, 248-252(7 Jul 1975).

The crossing of the classical positive and negative energy states $E^+$ and $E^-$ introduced by Christodoulou–Ruffini and interpreted within the framework of a relativistic quantum field theory by Deruelle and Ruffini, leads to a Klein paradox. It has been shown by Euler and Heisenberg that when the transmission coefficient $T^2$ through the barrier between the $E^+$ and $E^-$ states is small it is proportional to the probability of pair creation. Numerical computations show that, in the case of a small Kerr black hole ($GM/c^2 \lesssim \hbar/\mu c$), the probability of pair creation of particles of mass $\mu$ is maximum when $E \sim \hbar\Omega$, where E is the energy of the created particles and Ω and M the angular velocity and the mass of the black hole. (auth)

**30100** CONFORMAL ANOMALIES AND THE RENORMALIZABILITY PROBLEM IN QUANTUM GRAVITY. Capper, D. M. (Queen Mary Coll., London (UK)); Duff, M. J. (King's Coll., London (UK)). Phys. Lett., A; 53: No. 5, 361-362(14 Jul 1975).

It has been suggested by several authors that the long-outstanding problem of renormalizing quantum gravity might be solved by appealing to conformal invariance. The purpose of this note is to point out that this is unlikely to be the case since conformal invariance is not a good symmetry at the quantum level i.e., the presence of conformal anomalies in these models will spoil renormalizability. (auth)

**30101** A NOTE ON GENERAL RELATIVISTIC DYNAMO MECHANISMS. Reinhardt, M. (Bochum Univ. (F. R. Germany). Astronomisches Inst.); Rosenblum, A. (Max–Planck–Institut fuer Physik und Astrophysik, Muenchen (F. R. Germany)). Phys. Lett., A.; 53: No. 4, 269-270(30 Jun 1975).

A previous investigation of a general relativistic primary dynamo mechanism based on the dragging of inertial frames, where the Cohen–Brill metric was used, is generalized to the case of the Kerr metric. It is shown that magnetic fields can be generated without the black hole being charged. (auth)

**30102** CYLINDRICAL SELF-GRAVITATING FLUIDS WITH PRESSURE EQUAL TO ENERGY DENSITY. Letelier, P. S. (Universidad Catolica de Chile, Santiago); Tabensky, R. R. Nuovo Cim.; 28B: No. 2, 407-414(11 Aug 1975).

Solutions of Einstein's field equations are obtained under the assumptions that the source of the gravitational field is a perfect fluid with pressure p, equal to the energy density w; the space-time is cylindrically symmetric; the metric is given by two functions of two variables. Solutions of the Cauchy problem associated with Einstein's field equations are obtained under the same assumptions and an additional natural boundary condition. The relation between characteristic coordinates and comoving ones is discussed. (auth)

**30103** ELASTIC AND THERMOELASTIC MEDIA IN GENERAL RELATIVITY. Barrabes, C. (Faculte des Sciences, Tours, France). Nuovo Cim.; 28B: No. 2, 377-394(11 Aug 1975).

A study is made of elastic media in general relativity; it is based on a relativistic generalization of the functional constitutive equations of continuous media of Truesdell and Noll. It is shown that it is possible to give a definition of hyperelasticity in general relativity, on condition that the existence of a reference state of minimum free energy is postulated. This approach allows one also on the one hand to study the case of relativistic elasticity under high pressure (cf. certain stellar models), and on the other hand to study thermoelastic media without the paradox of infinite velocity of heat conduction. (auth)

**30104** LOCAL NEWTONIAN GRAVITATIONAL CONSTANT IN WHITEHEAD'S THEORY. Chiang, C. C.; Hamity, V. H. (Max Planck Inst. for Physics and Astrophysics, Munich). Lett. Nuovo Cim.; 13: No. 12, 471-475(19 Jul 1975).

It has recently been proposed that with a proper reinterpretation, Whitehead's theory of gravitation can be made to agree with Einstein's general relativity theory in its prediction of the local measurement of the Newtonian gravitational constant, G. It is pointed out, however, that this reinterpretation does not provide a unique space-time geometry for a general gravitational system. The theory is applied to a discussion of an Earth-gravimeter Cavendish experiment to calculate the locally measured gravitational constant. The results are different in Whitehead's theory and in general relativity. (SDF)

**30105** PRACTICAL QUANTUM MECHANICS. Fluegge, S. New York; Springer-Verlag, New York, Inc. (1971). 302p. $14.80.

The discussion covers one-body problems with and without spin, many-body problems, nonstationary problems, the relativistic Dirac equation, and radiation theory. (JFP)

**30106** MECHANIK, RELATIVITAET, GRAVITATION. (Mechanics, Relativity, Gravitation). Falk, G. (Karlsruhe Univ. (TH) (F.R. Germany). Inst. fuer Mathematische Physik); Ruppel, W. (Karlsruhe Univ. (TH) (F.R. Germany). Inst. fuer Angewandte Physik). Berlin; Springer-Verlag (1973). 455p.

183 figs.; 3 tabs.

Experimental physics and theoretical physics are considered as one. The concepts energy, momentum and angular momentum are the main topics. Physically useful movement is explained as the transport of energy and momentum. The transport processes are subdivided into geometrically localizable (bodies) and non-localizable (fields). Thus an access to the special and general relativity theory results directly from the equivalence of mass and energy as well as the equality of heavy and carrier mass. Problems and results in present research — especially in the fields of atomic and nuclear physics and gravitation — are included. (GE)

**30107** REMARKS ON GAUGE THEORIES OF FUNDAMENTAL FORCES. Chela-Flores, J. (International Centre for Theoretical Physics, Trieste, Italy). Int. J. Theor. Phys.; 13: No. 1, 17-25 (May 1975).

By clarifying the concepts of strong and weak gravity in a scalar-scalar-tensor theory of gravitation, an action principle is studied from which several theories of weak and (separately) strong gravity are discussed. By further appealing to the general principle of gauge invariance it is possible to discuss gauge theories of spontaneously broken discrete symmetries. Finally, it is found that super-heavy gauge bosons are automatically excluded when both gravities are properly understood. (auth)

**30108** GRAVITATIONAL ENERGY FLUX IN THE WAVE ZONE WITH THE COORDINATE CONDITIONS OF INFEL'D. Petrova, N. M. (Kazan Pedagigical Inst.). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 3, 117-121(1975). (In Russian).

The spacial mode of measurement and gravitational energy flux in the wave zone under the coordinate conditions of Infel'd is discussed. As the calculations show, the emission energy under these conditions has the same value as under conditions of harmonicity, despite the assertion of Infel'd that under the coordinate conditions that found this energy goes to zero. (tr-SJR)

**30109** SPINOR FIELDS IN THE THEORY OF RELATIVITY AND A GENERALIZATION OF HEISENBERG'S NONLINEAR SPINOR EQUATION. Ulmer, W. (Univ., Heidelberg). Int. J. Theor. Phys.; 13: No. 1, 51-72(May 1975).

Some years ago it was shown that the nonlinear term of Heisenberg's spinor equation can be derived by torsion of the Minkowski space (Cartan space). This result is applied in the investigations presented. As the Heisenberg equation does not show any connection with recent phenomenological theories in high energy physics, like the parton or quark model, the problems of the metric of space-time are discussed from the aspect of fundamental axioms of topology (Hausdorff space). It is shown that Feynman's relativistic parton theory can be derived by means of a quantized de Sitter space, where the constant curvature can assume only discrete values. It is also possible to derive the Dirac equation from the same mathematical considerations. A nonlinear spinor equation is formulated which contains the parton theory and the nonlinear term of the Heisenberg equation as different approaches in the theory of elementary particles. (auth)

**30110** EINSTEIN PARADOX AND NEW MIXING PARADOX. Bazarov, I. P. (Moscow State Univ.). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 39-43(1975). (In Russian)

The Einstein paradox during isothermal mixing of quantum ideal gases and a new paradox during the adiabatic mixing of these gases were examined. A solution of both paradoxes was given. (tr-auth)

**30111** WEAK CYLINDRICAL GRAVITATIONAL WAVES. Radchenko, V. E. (Moscow State Univ.). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 7-11(1975). (In Russian).

The linearized Einstein equations without the right-hand side were examined in the background of two-dimensional metrics in cylindrical coordinates. By irreducible representation resolution of the group with cylindrical symmetry, general solutions were obtained. The solutions were studied with consideration of the supplementary conditions observed in physico-geometric values during monad selection of the system of reference in the chronometric and kinematic calibration. (tr-auth)

**30112** MIXED PROBLEM FOR THE EINSTEIN EQUATION. Kucherenko, E. I.; Loskutov, A. V. (Ryazan Radiotechnical Inst., USSR). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 104-110(1975). (In Russian).

In the study of the theory of gravitation problems arise as in the Cauchy problem on mixed problems with different modifications of the boundary conditions. The Cauchy problem can be divided into two parts, and the various approaches made to the solution of each are outlined. A generalized solution of this problem is given and the actuality and uniqueness of this solution are proven. The Galerkin method for the solution of the Cauchy problem is given. (JSR)

**30113** GRAVITATIONAL STRINGS IN ELEMENTARY PARTICLE MODELS. Ivanenko, D. D.; Burinskii, A. Ya. (Moscow State Univ.). Izv. Vyssh. Uchebn. Zaved., Fiz.; No. 5, 135-137 (1975). (In Russian).

The role of gravitation in the structure of elementary particles is approached by a new analogy of relativistic strings and monopoles with threads in the solutions of the Einstein-Maxwell equation. (JSR)

**30114** GRAVITATION AND BILOCAL FIELD THEORY. Vollendorf, F. Z. Naturforsch., A; 30: No. 5, 642-644(May 1975). (In German).

5 refs.

The starting point is the conjecture that a field theory of elementary particles can be constructed only in a bilocal version. Thus the 4-dimensional space time has to be replaced by the 8-dimensional manifold $R^8$ of all ordered pairs of space time events. With special reference to the Schwarzschild metric it is shown that the embedding of the time space into the manifold $R^8$ yields a description of the gravitational field. (auth)

**30115** f-GRAVITY AND SPINORS IN GENERAL RELATIVITY. Sivaram, C.; Sinha, K. P. (Inst. of Science, Bangalore). Lett. Nuovo Cim.; 13: No. 10, 357-363(5 Jul 1975).

A space-time-dependent spinor representation is used in a coupling of spinor and gravitational fields in order to investigate the connection between general relativity and elementary particles. A possible connection of the formalism with weak interactions is pointed out. (SDF)

# REACTOR TECHNOLOGY AND REGULATION

**30116** (GA-A-13396) GENERALIZED HYDRODYNAMIC EFFECTS OF A DOUBLE ANNULUS ON A VIBRATING CYLINDRICAL SHELL. Penzes, L. E.; Bhat, S. K. (General Atomic Co., San Diego, Calif. (USA)). 15 Aug 1975. Contract AT(04-3)-167. 18p. (CONF-750908-7). Dep. NTIS $4.00.

From 3rd international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Problems in reactor operation arising from flow-induced vibrations have been the target of recent investigations. Vibratory stresses and dynamic stabilities of reactor internals that are probably due to turbulent flow, von Karman vortices, and flow-induced, self-excited vibration are some of the topics covered. In this paper, theories are combined and generalized to investigate: (1) the generalized virtual mass effect, (2) the dynamic pressure distribution on a cylindrical shell during rapid depressurization, and (3) the dynamic stability of shield structures. (auth)

**30117** (INIS-mf-1510) TOWARDS THE ESTABLISHMENT OF NUCLEAR POWER PLANTS IN THE PHILIPPINES. Ibe, L. D. (Philippine Atomic Energy Commission, Manila). 1974. 11p. (CONF-740375-2). INIS.

From annual convention of the Chemical Society; Manila, Philippines (28 Mar 1974).

The need to find other sources of power and energy for the Philippines' economic survival is discussed. The Philippines import about 65 million barrels of crude petroleum from which power and energy is generated for the operation of the following: transportation service, 45%; public utilities, 18%; manufacturing industries, 15%; household uses, 8%; agricultural industries, 4%; and others, 5%. About 92% of the country's total energy requirements is supplied by imported crude oil, 7% from the hydroelectric plants of the National Power Corporation, and 1% by coal-fired thermal plants. The Philippine Atomic Energy Commission, foreseeing the technical and economic advantage of nuclear power, initiated the pre-investment study of nuclear power in the Luzon area with the assistance of IAEA in 1962. The study undertaken in 1964–1966 showed that electricity generated from a 300 MW nuclear power plant could be marginally competitive with a conventional oil-fired station of the same size. In 1971, PAEC with the aid of the UNDP made a "Feasibility Study for a Nuclear Power Plant in Luzon." The study showed the feasibility of introducing a 600 MW nuclear power plant in the Luzon Grid. With the continued increase of oil prices, a nuclear power plant is not only competitive but more economical. The National Power Corporation has started planning for the first 600 MW nuclear power plant in the Philippines. (INIS)

**30118** (INIS-mf-1680) DEVELOPMENT OF NUCLEAR ENERGY IN INDIA: 1947-73. Ramanna, R. (Bhabha Atomic Research Centre, Bombay (India)). 1974. 23p. INIS.

Lecture delivered at the Nehru Memorial Museum, New Delhi on 29th July 1974; also published in two parts in Nucl. India (Aug 1974) v.12(2) p. 4-7 and (Sep 1974) v.13(1) p. 4-6.

The tremendous progress in the research and development work in the nuclear energy field in India during the period of 1947-73 is reviewed. A brief mention is made of the state of organization of scientific research in India before independence. (INIS)

**30119** POWER PLANT CONSTRUCTION TODAY: DEVELOPMENT TASKS FOR TOMORROW. Stoll, A. (Kraftwerk Union A. G., Erlangen (F. R. Germany)). Tech. Mitt.; 68: No. 1/2, 8-11(1975). (In German).

The future of nuclear energy after the light-water reactor is analyzed: high-temperature reactor, breeder, nuclear fusion. Medium-term prospects of development with a fossil primary energy carrier are described: synthetic methane production, $H_2$ technology. Environmental factors are discussed such as cooling, air pollution, and waste materials. (GE)

**30120** HYDROGASIFICATION OF COAL. Teggers, H. GWF Gas-Erdgas.; 115: No. 12, 532-537(Dec 1974). (In German).

In the Federal Republic of Germany, of the different coal gasification methods, the hydrogasification of coal is especially sponsored for the substitution of synthetic fuels, such as methane, carbon monoxide, and hydrogen, for natural gas. The present state of development is described and methods of introducing process heat from gas-cooled high-temperature nuclear reactors into the gasification process are mentioned. (GE)

**30121** DISTRICT HEATING SUPPLY BY NUCLEAR POWER PLANTS. KWU-Rep.; No. 18, 1-7(Apr 1975). (In German).

7 figs.

The possibilities of district heating of the FRG are discussed with special emphasis on the use of the pressurized-water reactor. Different types of combined heat and power generation are discussed with regard to optimum efficiency. These total-energy concepts are designed to meet the varying demands for heat and power generation. (GE)

**30122** TERM "AVAILABILITY" AS USED IN CONNECTION WITH NUCLEAR POWER STATIONS. Fehndrich, W.; Kutsch, W. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (F.R. Germany). Hauptverwaltung). Atomwirtsch., Atomtech.; 20: No. 6, 288-292(Jan 1975). (In German).

1 fig.; 1 tab.; 12 refs.

The increase in the nuclear generating capacity installed has resulted in a general discussion about the availability to be expected from nuclear power stations. Comparisons of statistical data on nuclear power plant operation frequently show that data on availability and plant factors of nuclear power stations may differ widely in some cases. Aside from errors, these discrepancies are due mainly to the different terms and definitions used by the institutions compiling these reports. In this contribution, first of all these institutions are listed and then the different terms and their definitions are given. It is seen that translations which are correct linguistically give rise to discrepancies because a term used is defined differently by different agencies. Because of these difficulties of definition, the applicability of the term "Arbeitsverfuegbarkeit" (availability in terms of work) as mentioned in many publications is greatly restricted. A comparison of the availability and plant factor data quoted by various organizations for several nuclear power plants indicates that there may be major differences even in those cases in which the same terms are used for the same parameters. (auth)

**30123** POSSIBLE NEW APPLICATION OF HTGR-PROCESS HEAT. Huwyler, S.; Seifritz, W. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Atomwirtsch., Atomtech.; 20: No. 6, 293-294(Jun 1975).

From international symposium on gas-cooled reactors with emphasis on advanced systems; Juelich, F.R. Germany (13 Oct 1975). 4 refs.

The paper discusses (1) the various methods of producing reducing gases ($H_2$, CO, $CH_4$) for zinc production by nuclear process heat, and (2) the Toth method of aluminium production, in the 4 stages of which nuclear process heat can be used. (GE)

**30124** NEW START FOR BRITAIN'S NUCLEAR PROGRAMME. Kenward, M. New Sci.; 67: No. 958, 158-159(17 Jul 1975).

To mark the 21st anniversary of the formation of the UKAEA a discussion with Sir John Hill, chairman of the UKAEA, is reported covering the present position of Britain's nuclear power program and the part played by the nuclear power industry. (UK)

**30125** POSSIBILITIES AND LIMITATIONS OF A NEW GASIFICATION TECHNOLOGY. Peters, W. VDI (Ver. Dtsch. Ing.). Ber.; No. 222, 55-59(1974). (In German).

1 fig.; 3 tabs.; 6 refs.

The gasification of coal with steam and oxygen to synthesis and heating gas is based on a technique developed and put into industrial operation before and during the war especially in Germany. The interest in coal gasification is being renewed. A possibility for saving coal in steam gasification and thus reducing the costs is seen in an allothermal procedure only using steam as the gasification agent and no longer using the relatively expensive oxygen, where the reaction heat is indirectly led in from the outside. This necessitates, however, the availability of cheap process heat to a temperature level of over 900°C, which can possibly be obtained from gas-cooled high temperature nuclear reactors. (GE)

**30126** DISKUSSION UEBER DAS 4. ATOMPROGRAMM. Dokumentation ueber die oeffentliche Diskussion des 4. Atomprogramms der Bundesrepublik Deutschland fuer die Jahre 1973-1976. (Discussion of the 4th Atomic Energy Program. Documentation on the Public Discussion of the 4th Atomic Energy Program of the FRG for the Years 1973-1976). Bonn; Bundesministerium fuer Forschung und Technologie (1974). 769p. (In German).

28 refs.

The public discussion held in Bonn on 12 February, 1973 is documented. (GE)

**30127** A PRELIMINARY STUDY OF DUAL PURPOSE NUCLEAR PLANT FEATURES FOR EGYPT. Fouad, H. Y. (Atomic Energy Commission, Cairo (Egypt)). Nucl. Eng. Des.; 32: No. 3, 402-409(1975).

Studies of future energy and water needs in Egypt showed the possibility of introducing nuclear power plants. Multi-stage flash-vertical tube evaporator coupling to such a plant could result in relatively cheap water desalination. Overall reactor design methodologies, including physical, thermal lifetime and economic analyses, were developed and verified with published data. A computer program was prepared and its use in overall plant optimization studies was indicated. Preliminary features for a 400 MW(e), 250 mgd, PWR plant were outlined. Complementary optimization studies are pointed out. (auth)

## Power Reactors, Non-Breeding, BWR-Type

*Refer also to abstracts 30299, 30303, 30304, 30308, 30319, 30321, 30325–30327, 30355, 30357, 30359, 30361, 30459, 30466, 30467, and 30473.*

**30128** (CONF-751101-6) CORE COMPONENT VIBRATION MONITORING IN BWRs USING NEUTRON NOISE. Fry, D. N.; Robinson, J. C.; Kryter, R. C.; Cole, O. C. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Neutron noise from in-core fission detectors in a BWR was investigated to determine its effectiveness as a monitor of mechanical vibrations of core components. In this study the general properties of BWR neutron noise were characterized, and a signal enhancement method was implemented to improve the measurement sensitivity. (auth)

**30129** (ERDA-tr-11) RESULTS OF CYCLIC PRESSURE LOADING TESTS ON JPDR PRESSURE VESSEL MODEL NO. 3. Fujimura, T.; Miyazono, S.; Ueda, S.; Namaiame, H.; Shibata, K.; Isozaki, T.; Oba, T.; Kawamura, R.; Matsumoto, M. Apr 1972. Translation of Jaeri-Memo-4807. 66p. Dep. NTIS $5.45.

Cyclic internal pressure tests were conducted on the No. 3 model pressure vessel in continuation of the tests conducted with the No. 1 and No. 2 models in the continuing effort to establish the structural safety of JPDR pressure vessels. The No. 1 and No. 2 models were $\frac{1}{3}$ scale models of the actual pressure vessel and were of the same shape. The No. 3 was a $\frac{1}{2}$ scale model to which 3 roughly $\frac{1}{4}$ scale model nozzles of the large type light water reactor were installed in addition to the JPDR forced circulation nozzle, and tests were conducted simultaneously. The results are presented. (auth)

**30130** (GEAP-10207-32) REACTOR PRIMARY COOLANT SYSTEM PIPE RUPTURE STUDY. Progress Report No. 32, July–December 1974. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Mar 1975. Contract AT(04-3)-189. 44p. Dep. NTIS $4.00.

The pipe rupture study is designed to extend the understanding of failure-causing mechanisms and to provide improved capability for evaluating reactor piping systems to minimize the probability of failures. Following a detailed review to determine the effort most needed to improve nuclear system piping (Phase I), analytical and experimental efforts (Phase II) were started in 1965. This progress report summarizes the recent accomplishments of a broad program in (a) basic fatigue studies focused on Elastic/Plastic ASME Code Design Rules, (b) at-reactor tests of the effect of primary coolant environment on the fatigue behavior of piping steels, and (c) studies directed at quantifying weld sensitization in T-304 stainless steel. (auth)

**30131** (HEDL-SA-911) NEUTRON ENVIRONMENTAL CHARACTERIZATION REQUIREMENTS FOR REACTOR FUELS AND MATERIALS DEVELOPMENT AND SURVEILLANCE PROGRAMS. McElroy, W. N.; Bennett, R. A.; Johnson, D. L.; Dudey, N. D. (Hanford Engineering Development Lab., Richland, Wash. (USA); Argonne National Lab., Ill. (USA)). 29 Aug 1975. 29p. (CONF-750935-7). Dep. NTIS $4.50.

From 1st ASTM-Euratom symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

Neutron environmental characterization requirements for reactor fuels and materials development and surveillance programs for Light Water Reactors (LWRs), High Temperature Gas-Cooled Reactors (HTGRs), Fast Breeder Reactors (FBRs), and Controlled Thermonuclear Reactors (CTRs) are varied. Presently, the most demanding requirements are associated with the development of FBRs where goal accuracies in the range of 1 to 3 percent (1 sigma) have been requested for the determination of fission rates, burnups, and neutron fluxes and fluences. Total fluence associated with a measured material property change in a fast test reactor can presently be determined in the 5 to 10 percent (1 sigma) range, and application of improved dosimetry techniques is expected to reduce this to the 2 to 5 percent (1 sigma) range. Without direct dosimetry measurements, however, uncertainties of 25 percent and more are not uncommon. International standardization, development, and application of improved dosimetry methods for reactor materials development and surveillance programs for LWRs, HTGRs, FBRs, and CTRs are essential. The discussion of requirements for neutron environmental characterization for these different reactor concepts is an important aspect of this conference. Here, these requirements are reviewed in light of currently known design, development, testing, and operation considerations for U.S. LMFBR and CTR programs. 97 references. (auth)

**30132** (NEDO-10951) RELEASES FROM BWR RADWASTE MANAGEMENT SYSTEMS. Head, R. A.; Miller, C. W.; Oesterle, J. E. (General Electric Co., San Jose, Calif. (USA). Atomic Power Equipment Dept.). Jul 1973. 43p. General Electric Co., San Jose, CA.

Estimates are presented of planned or expected radioactive emissions from the waste systems associated with the General Electric BWR/6 standard plant design. The system and equipment performance experience is documented, and the calculational methods used in estimating effluent releases are described. The waste systems discussed include the low temperature recombiner-charcoal (RECHAR) off-gas treatment system and the evaporator, traveling-bed filter-type liquid-solid radwaste treatment systems. Inputs to the waste systems are based on a single 3833 MWt BWR/6 plant incorporating deep bed condensate polishers and powdered resin reactor water cleanup demineralizers. 11 references. (auth)

**30133** (RT/ING-(75)3) TWO-PHASE FLOWS THERMO-HYDRAULICS IN BOILING AND PRESSURIZED WATER REACTORS. Vol. I. Marinelli, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1975. 311p. (In Italian). Dep. NTIS (US Sales Only) $18.75.

Two-phase flows thermo-hydraulics is a new scientific branch, born during the development of water reactors. The present status of this subject is similar to a wide and uncompleted mosaic of empirical observations, data, correlations, whose tesseras do not always fit each other well. The reasons are both the urgent need to have design engineering information and therefore the constant recourse to particular experiments around the working conditions, and the real difficulties met were interpreting and describing the complex phenomena associated with two-phase flows under heat transfer. The aim of this book is to offer a collection of the main calculation methods and an up-to-date synthesis of the state-of-the art; in this first volume five main items, ordered in a logical sequence are presented, i.e.: two-phase flow regimes, void fraction, pressure drops, heat transfer in the pre-crisis region, heat transfer crisis, all such problems are treated from an engineering point of view. (auth)

**30134** (TID-8200-R32) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF JUNE 30, 1975. (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). 1975. 44p. Dep. NTIS $4.00.

Information is tabulated on nuclear reactor and critical assembly facilities in operation, shut down, under construction, or planned in the U. S. Data are included on name, location, type, power, and startup date.

**30135** (XN-75-32-NP) COMPUTATIONAL PROCEDURE FOR EVALUATING FUEL ROD BOWING (AXIBOW). Merckx, K. R. (Exxon Nuclear Co., Richland, Wash. (USA)). Jul 1975. 43p. Exxon Nuclear Co., Inc., Richland, WA.

A computer program called AXIBOW has been developed to evaluate the bowing of reactor fuel rods. The theoretical bases for this program and the results of sensitivity studies on the bowing of a typical PWR fuel rod are presented. The computer program is a finite element code using beam elements with axial thrust and linear spring elements for nodal restraints. The effects of axial thrust, creep relaxation, irradiation induced growth, anisotropic creep, initial curvature, temperature and flux gradients, eccentric cross sectional geometries, and axial thrust relaxation can be evaluated with this code. The sensitivity studies included variations of axial thrust, pressure differential, initial curvature, mean cladding temperatures, neutron fast flux level, support rotational restraint, lateral temperature and flux gradients, clad thickness, tubing anisotropy and eccentricity, thrust relaxation, and multispan restraint. For the prototypic conditions

of a PWR fuel rod, the axial thrust and the support rotational restraint are the primary parameters influencing the inherent structural stability of a fuel rod support system design. Thrust relaxation and rod restraint in multispan rods subjected to different operational environments in the various spans also significantly affect rod bow. The AXIBOW code has sufficient capability to directly evaluate all of the factors included in the sensitivity study and can be used to model prototypic conditions for a fuel rod with multiple spans. (auth)

**30136** MODELING OF FLOW-INDUCED VIBRATIONS IN HEAT EXCHANGERS AND NUCLEAR REACTORS. Beavers, G. S.; Plunkett, R. (Univ. of Minnesota, Minneapolis). J. Fluids Eng.; 96: No. 4, 358-364(Dec 1974).

From joint fluids engineering and CSME conference; Montreal, Quebec (13 May 1974).

Appropriate scaling factors for the modeling of the fluid-mechanical interaction of complex structures are discussed. The possible mechanisms of flow-excited vibration are described, and scaling parameters are derived from considerations of the mechanical and fluid systems. Emphasis is placed on flow-induced vibrations of banks of cylinders in single phase, high Reynolds number, turbulent, cross flow, as occur for example in light water nuclear reactors and heat exchangers. It is concluded that the modeling of the tube banks in light water nuclear reactors will involve a mismatch of Reynolds number, but that the major phenomena of fluid-solid interaction in the single-phase flow region will probably be closely replicated if the Reynolds number is high enough so that the entering flow is turbulent and if the scaling ratio is not too large. (auth)

**30137** RECYCLING ION EXCHANGE RESINS. Lannin, T. E. (General Electric Co., Pleasanton, CA). Power Eng.; 79: No. 9, 52-54(Sep 1975).

An ultrasonic cleaning system is described which permits recycling of ion exchange resins used in BWR feedwater demineralizers. (DG)

**30138** PIPING PENETRATIONS FOR NUCLEAR POWER PLANTS. Purdy, D. C., Bacharier, J.; Berzak, N. (Gibbs and Hill, Inc., New York). Heat., Piping Air Cond.; 47: No. 4, 49-55 (Apr 1975).

Design characteristics and requirements for PWR and BWR containment building pipeline penetrations are presented. Temperature distributions in containment pipeline penetrations are analyzed. (DCC)

**30139** HYDROGEN RECOMBINATION SYSTEM FOR LIGHT-WATER REACTORS, AFTER A LOSS-OF-COOLANT ACCIDENT. Henrie, J. O. (Atomics International Div., Canoga Park, Calif. (USA)); Gregor, F. E.; Honkala, J. W. (Detroit Edison Co., Mich. (USA)). Arch. Energiewirtsch.; 29: No. 5, 460-461(May 1975). (In German).

The processes leading to accumulation of hydrogen (possibly in an hydrogen-oxygen mixture) in water-cooled nuclear reactors after loss of coolant due to a leak, and the most relevant articles of the safety regulations of the Atomic Energy Commission are cited. The thermal recombination system constructed for the Fermi-2 facility meets all technical safety standards and will be incorporated in the hydrogen control systems of the fast breeder BWR Mark I and II pressure vessels as a regular constructional part. (GE)

**30140** STEAM-GENERATOR TUBE FAILURES: WORLD EXPERIENCE IN WATER-COOLED NUCLEAR POWER REACTORS IN 1973. Stevens-Guille, P. D.; Hare, M. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Saf.; 16: No. 5, 603-613(1975).

A summarization is presented of steam-generator tube failures in water-cooled reactors for 1973. Failures occurred in 11 of 49 reactors, mainly due to corrosion and vibration. The two most important variables in preventing these failures appear to be secondary-water chemistry and design. (auth)

**30141** KERNTECHNISCHE ANLAGEN. Lagerbecken fuer Brennelementbuendel bei Wassergekuehlten Leistungsreaktoren. Entwurf. (Nuclear Facilities. Pool Facility for Fuel Assemblies for Water-Cooled Power Reactors. Draft). Berlin; Beuth (Apr 1975). 7p.

1 tab.

The draft standard applies to water-filled storage pools in passable rooms in a BWR or PWR for: concepts, layout (take-up of loads, sufficient carrying capacity, sufficient shielding, criticality safety, cooling, cleaning), materials and fabrication processes, construction and production, acceptance tests, operation, other valid standards. (GE)

## Power Reactors, Non-Breeding, PWR-Type

*Refer also to abstracts 30121, 30131, 30133–30136, 30138–30141, 30299–30303, 30306, 30308, 30325, 30326, 30341–30346, 30351, 30353, 30354, 30357, 30359, 30361, 30458, 30466, 30467, and 30471.*

**30142** (BAW-10072A) SAVER: DIGITAL COMPUTER CODE TO DETERMINE PRESSURE DROPS. Galan, V. J.; Brantley, J. T. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Sep 1975. 50p. Babcock and Wilcox Co., Lynchburg, VA.

The SAVER code calculates the steady-state flow and pressure drop in all paths of an arbitrary flow network. SAVER calculates elevation and momentum recoverable pressure drops and the types of unrecoverable pressure drops encountered most often. The pressure drop in each path is the sum of the elevation, momentum, and unrecoverable pressure drops. The momentum and unrecoverable pressure drops are expressed as $R \times W^2$, where R is the resistance to flow and W is the flow rate. The elevation pressure drop is not a function of flow rate. The elevation pressure drop and the resistances to flow are calculated using the B and W standard methods. A set of flow and pressure drop equations is written using these values. First, N-1 flow balance equations are written, where N is the number of flow path junctions in the network. Then, all the unique pressure drop balance equations are written, considering that the pressure drop across each path through the network must equal the pressure drop imposed by the boundary conditions. These equations are then solved for the flow rate in each path. (auth)

**30143** (INIS-mf-1702, pp 224-250) DEVELOPMENT OF THE WWER-TYPE REACTOR NUCLEAR POWER STATIONS IN THE USSR. Sidorenko, V. A. 1974. (In Russian).

In nuclear power plant operating experience and prospects of nuclear power engineering. Vol. 1. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow).

The trends in the development of the basic engineering characteristics of nuclear power plants with WWER-type reactors, including increase of the unit power, improvement of the fuel cycle economy, and consolidation of instrumentation, were discussed. The construction singularities caused by the reactor instrumentation and the trends for improvement of the instrumentation, including steam generators, circulating pumps, piping, and volume compensators, were examined. The development trends in guaranteeing the safety of WWER nuclear power plants were discussed. The purposes and means of achieving safety were formulated. (tr-auth)

**30144** (WCAP-7813-A) ROD BUNDLE AXIAL NON-UNIFORM HEAT FLUX DNB TESTS AND DATA. Rosal, E. R.; Cermak, J. O.; Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Jan 1975. 128p. Westinghouse Electric Corp., Pittsburgh.

A description is given of an extensive experimental program performed to investigate the behavior of Departure from Nucleate Boiling (DNB) in electrically heated rod bundles simulating a portion of a nuclear power reactor assembly. Effects on DNB due to non-uniform axial heat flux distribution, heater rod lengths, rod spacer grids with and without mixing vane and axial grid spacing were investigated. The experimental parameters investigated were pressure, inlet temperature, and inlet mass velocity. The 284 DNB data points obtained were compared with DNB heat fluxes predicted by the non-uniform heat flux W-3 correlation (with spacer factor) which is based on single channel data. The predicted DNB heat flux values were based on local conditions calculated by the THINC computer code. The results verified that this correlation can accurately predict the DNB heat fluxes in axially non-uniform heat flux rod bundles. (auth)

**30145** (WCAP-8576) AUGMENTED STARTUP AND CYCLE I PHYSICS PROGRAM. Jones, K. A.; Little, C. C.; Henderson, W. B. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Aug 1975. 36p. Westinghouse Electric Corp., Pittsburgh, PA.

Augmented Initial Startup Tests and Augmented Cycle I Physics Tests have been developed to satisfy NRC and ACRS concerns related to transient peaking factor measurement and design code verification for Westinghouse PWRs. A new method for measuring power distribution, the quarter-core flux map, has been incorporated into the program. The program will be carried out at four plants according to a schedule designed to support the design bases of these and future reactors of the same generation. (auth)

**30146** CONSTRUCTION STOP FOR THE WYHL NUCLEAR POWER PLANT. Energiewirtsch. Tagesfragen; 25: No. 4, 172-177(1975). (In German).

At the request of 4 communities and 6 private persons, the Freiburg administrative court has, by verdict dated 14th March 1975—VS II 26/75—re-established the suspensive power of the applicants' action against the 1st partial licence for the construction of Kernkraftwerk Sued, Block 1, in Wyhl. (HP/LN)

**30147** CONSTRUCTIONAL LAYOUT OF THE MUELHEIM-KAERLICH NUCLEAR POWER STATION. Peter, F. (Brown, Boveri und Cie A. G., Mannheim (F. R. Germany). Geschaeftsbereich Kraftwerke). Atomwirtsch., Atomtech.; 20: No. 5, 246-253(May 1975). (In German).

The construction concept emphasizes protection against external influences, complete separation of the nuclear and the conventional area, and sufficient redundance of all important structural components. The reactor building and the reactor auxiliary buildings together constitute a closed controlled area. The heavy components can be inserted into the containment at ground level. The thermal power is conducted into the water-steam loop by two straight-tube steam generators. A natural-draught cooling tower for recirculation of the cooling water is still in the planning stage. The turbo-generator set consists of a condensation turbine with three casings and a directly coupled 1,500 revolutions-generator. (GE)

**30148** STAGES IN PLANNING AND CONSTRUCTION OF THE MUELHEIM-KAERLICH NUCLEAR POWER STATION. Pracht, F. (Rheinisch-Westfaelisches Elektrizitaetswerk A. G., Essen (F. R. Germany). Kraftwerksplanung). Atomwirtsch., Atomtech.; 20: No. 5, 245-246(May 1975). (In German).

On October 23, 1972, RWE gave a letter of intent and on January 9, 1973 an order for the construction of a nuclear power plant on a turn-key basis to the consortium of BBC, BBR and Hochtief. The power plant in question was the Muelheim-Kaerlich nuclear power station with a pressurized-water reactor of a gross rating of 1,295 MW(e). After considerable delay of the project, the first building permit was issued to the builder-owner on January 15, 1975, and the constructional work on the building site started immediately afterwards. As the planning and constructional work has so far been carried out according to schedule and the consortium intends to keep the effects of the belated license as small as possible, the start-off of the plant will probably be in summer 1979 if the construction work is not interrupted. (GE)

**30149** LAYOUT OF THE MUELHEIM-KAERLICH REACTOR. Schatz, A. K. (Babcock-Brown Boveri Reaktor G. m. b. H., Mannheim (F. R. Germany)). Atomwirtsch., Atomtech.; 20: No. 5, 253-258(May 1975). (In German).

The BBR pressurized-water reactor is characterized by a dual-cycle plant. Its straight-tube steam generators employ the once-through principle to generate superheated steam. The basic unit of the steam generation system is the pressurized-water reactor developed by the American Babcock and Wilcox Company which has been adapted to the German construction and safety regulations without changes in its basic conception. The steam generation system has two parallel coolant loops—each with its own steam generator, two recirculating pumps, one hot and two cold lines. In the primary system, afterheat removal is only possible by natural circulation. The same standardized fuel elements are used for reactors of different power—205 fuel elements in Muelheim-Kaerlich. (GE)

**30150** BIBLIS NUCLEAR POWER STATION AS SEEN FROM THE OPERATOR'S POINT OF VIEW. Eitz, A. W.; Dieterich, L. (Rheinisch-Westfaelisches Elektrizitaetswerk A. G., Essen (F. R. Germany)). Kerntechnik; 17: No. 4, 157-160(Apr 1975). (In German and English).

With the first feeding into the grid from Biblis on August 25, 1974, as well as with the attainment of its 100% power output an December 5, 1974, RWE's decision taken in 1969 to build a 1,200 MW nuclear power plant was justified. The expected technical problems related to the plant as well as to the grid were solved within the original estimates. Moreover, it became evident that the magnitude as well as the smooth handling of the project require standardization for erection as well as licensing purposes. (auth)

**30151** COMMISSIONING OF UNIT A OF THE BIBLIS NUCLEAR POWER STATION. Ritter, M.; Wienken, P. (Kraftwerk Union A. G., Erlangen (F. R. Germany)). Kerntechnik; 17: No. 4, 168-177(Apr 1975). (In German and English).

The interplay of all individual systems was checked during the subcritical hot trial operation phases. The numerous measurements and subsequent inspections showed that all the components satisfy the stipulated requirements. The first criticality was followed by zero-power trial operation during which a schedule of measurements pertaining to reactor physics was carried out. The performance of the complete plant in normal operation and in exigencies was checked by means of experiments during consecutive phases of power operation. (auth)

**30152** BIBLIS NUCLEAR POWER STATION. Energie; 27: No. 4, 95-105(Apr 1975). (In German).

A short description of the components of the Biblis nuclear power station is given. In addition to the heat flow diagram, the coolant cycle and the turbine control system, some details of construction and reactor safety are presented. (GE)

**30153** ORDER AGAINST GRAFENRHEINFELD REVERSED. Energiewirtsch. Tagesfragen; 25: No. 1/2, 51-58(1975). (In German).

On the decision of the Bavarian Administrative Court of November 22, 1974, the decision of the Wuerzburg Administrative Court of August 26, 1974 (ET 11/74, p. 587) ordering a stop of construction in the Grafenrheinfeld nuclear power station was reversed on the appeal of Bayernwerk AG and Kraftwerk Union AG. The costs, including the extrajudicial costs of the two companies under subpoena as witnesses, were awarded against the petitioner—the city of Schweinfurt. The value of matter in controversy was taxed at 50,000 DM. The substance of the opinion is given in the article. (GE)

**30154** STEAM POWER PLANT WITH A PRESSURIZED-WATER REACTOR AND SEVERAL STEAM GENERATORS HEATED WITH PRESSURIZED WATER. Kelp, F. (to Kraftwerk Union AG). German(FRG) Patent 2,351,678/A/. 24 Apr 1975. 11p. (In German).

5 figs.

The efficiency of steam generators in pressurized-water reactors is to be increased by step switches. A circuit diagram shows the steam cycle of the reactor up to the turbines. (GE)

## Power Reactors, Non-Breeding, Graphite Moderated

*Refer also to abstracts 30123, 30125, 30131, 30134, 30305, 30312, 30320, 30330, 30332, 30333, 30360, 30362, and 30440.*

**30155** (AERE-R-8065) METAL FISSION PRODUCT BEHAVIOUR IN HTR $UO_2$-COATED PARTICLE FUEL. Brown, P. E.; Brownsword, M.; Faircloth, R. L.; Inns, A. J.; Hooper, E. W. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jun 1975. 30p. Dep. NTIS (US Sales Only) $4.50. UK.

A discussion of metal fission product behavior in high temperature reactor coated fuel particles is presented, commencing with the release from the $UO_2$ kernel followed by diffusion in the pyrocarbon coatings. The discussion centres mainly on the four key fission products although the properties of some other metallic fission products will be mentioned briefly. Some evidence for the permeation of silicon carbide by strontium and silver under certain conditions is also presented. (auth)

**30156** (CONF-750928-1) ADVANCED NUCLEAR REACTORS. Trauger, D. B. (Oak Ridge National Lab., Tenn. (USA)). 1975. 7p. Dep. NTIS $4.00.

From nuclear power and applications in Latin America; Mexico City, Mexico (29 Sep 1975).

Advanced nuclear reactors are assumed to be those not yet in service commercially. Included in this discussion, therefore, are the High Temperature Gas-Cooled Reactor (HTGR), the Steam Generating Heavy Water Reactor (SGHWR), the Light Water Breeder Reactor (LWBR), the Liquid Metal Fast Breeder Reactor (LMFBR), the Gas-Cooled Fast Breeder Reactor (GCFBR), and the Molten Salt Breeder Reactor (MSBR). The light water, magnox, and heavy water CANDU reactors are not included. Design characteristics and development programs for each type are reviewed. (auth)

**30157** (CONF-751007-1) FISSION PRODUCT BEHAVIOR DURING OPERATION OF THE SECOND PEACH BOTTOM CORE. Malinauskas, A. P.; de Nordwall, H. J.; Dyer, F. F.; Wichner, R. P.; Martin, W. J.; Kolb, J. O. (Oak Ridge National Lab., Tenn. (USA)). 1974. 18p. Dep. NTIS $4.00.

From IAEA international meeting on gas-cooled reactors; Julich, F.R. Germany (13 Oct 1975).

The Peach Bottom high-temperature, gas-cooled reactor began operation June 1, 1967 and continued power production until October 9, 1969, accumulating 452 equivalent full power days (EFPD) operation. After reload, power production with Core 2

began July 14, 1970 and terminated October 31, 1974 after 899 EFPD operation. Surveillance of fission product release and behavior was intensified during Core 2 operation to permit a wider range of measurements to be made. In addition to monitoring the fuel element purge system and noble gas content of the coolant circuit, the program was extended to include measurements of radioactive and other condensible species (including dust) entering and exiting the core and steam generator, and of surface concentrations of gamma-emitting nuclides deposited on the primary coolant surfaces. These data, which were obtained over the operating period April, 1971-October, 1974, are summarized and discussed. The data demonstrate that cesium behavior in the coolant circuit during the first two-thirds of Core 2 life was primarily governed by cesium released during Core 1 operation. The data also indicate that whereas the steam generator surfaces attenuate molecular cesium concentrations in the coolant, the dust-borne component is remarkably persistent. Driver fuel elements were removed from the reactor after 384 EFPD, 701 EFPD, and at end of life. These fuel elements are at various stages of an intensive post-irradiation examination. Some of the axial and radial concentration profiles of fission products which have been obtained are likewise presented. Although these profiles indicate varied fission product behavior, the observations can in general be qualitatively described on the basis of the operational histories of the fuel elements. (auth)

**30158** (DP-Report-744) PRESENCE OF Ag-111 IN THE DRAGON PRIMARY COOLANT CIRCUIT. Dragon Project Report. Rowland, P. R.; Browning, W. E.; Hatton, D.; Harris, A. M. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Oct 1971. 17p. Dep. NTIS (US Sales Only) $4.00.

The helium coolant of the Dragon Reactor has been sampled to determine the radioactive species present in the gas. Active silver isotopes have been found in relatively large quantities when compared with the usual isotopes expected in the coolant gas. It is suggested that the silver originates from fission and is more readily released than iodine, caesium or inert gases. Possible release mechanisms for silver are suggested. 9 references. (auth)

**30159** (DP-Report-754) ESTABLISHMENT OF COMPLETE FISSION PRODUCT INVENTORIES FOR IRRADIATED FUEL ELEMENTS. Dragon Project. Hick, H.; Lammer, M.; Nabielek, H.; York, J. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). May 1971. 138p. Dep. NTIS (US Sales Only) $10.00.

By a combination of gamma-spectrometric measurements and theoretical calculations a complete and accurate fission product inventory can be established. The basic idea is to use the experimental results for Cs-137 and Cs-134, together with a knowledge of the irradiation history, as a guide to derive proper neutron flux input data for the computer calculations. The result is a fission product inventory of any desired degree of completeness. The accuracy is verified by observing good agreement between theoretical and experimental results for a number of fission products which can be determined accurately by gamma-spectrometry. Due to recent improvements and widespread application of Ge(Li)-detectors, the gamma-line data for fission products have dramatically increased in number and accuracy during the last year. By means of the gamma-line table and the computer program IRREL, a quantitatively reliable interpretation of even the weak gamma-lines in a complex fuel element spectrum is possible. The complete fission product inventory of irradiated fuel elements can therefore be reliably established on a routine basis by a few measurements with a Ge(Li)-spectrometer and supporting computer calculations. (auth)

**30160** (DP-Report-765) FLATTER: A ONE-DIMENSIONAL EQUILIBRIUM FUEL MANAGEMENT PROGRAMME FOR CONTINUOUSLY ON-LOAD REFUELLED HIGH TEMPERATURE REACTORS. Dragon Project. Pedersen, J. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Sep 1971. 24p. Dep. NTIS (US Sales Only) $4.25.

FLATTER is a one-dimensional program specifically designed for the calculation of equilibrium fuel management in on-load-refuelled, high temperature reactors. The program is made very fast by the adoption of an analytical burn-up subroutine which avoids the usual step-by-step burn-up calculation and instead at once calculates the equilibrium composition of fuel, when the feed composition is given. Since the neutron spectrum is very important in high temperature reactors, a fast spectrum calculation in 43 groups is incorporated in the program, which will be entered for each reactor region with the material composition of that region and the bucklings, obtained with an up to 7-group diffusion calculation. Consistency between the diffusion calculation and the parameters used in defining the spectrum in each region is ensured with repeated iterations between the spectrum and diffusion calculations. The program will flatten the power distribution according to one of the following options: "Self-flattening" in which the fuel is assumed to have a constant residence time, so that high flux regions get high burn-up, and low flux regions low burn-up and this will tend to flatten the power distribution due to the burn-up; "Enrichment-flattening" in which the feed enrichment of different core regions will be automatically adjusted until overall power flattening has been obtained; and "Burn-up-flattening" in which the burn-up of different core regions will be adjusted until the power flattening has been obtained. (auth)

**30161** (DP-Report-802) DRAGON OPERATIONS BRANCH TWENTY-SIXTH QUARTERLY PROGRESS REPORT, OCTOBER–DECEMBER 1971. Dragon Project Report. Mason, I. K. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jul 1972. 33p. Dep. NTIS (US Sales Only) $4.75.

**30162** (DP-Report-803) HTR FUELS AND THEIR FURTHER DEVELOPMENT. Dragon Project. Graham, L. W.; Price, M. S. T. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jul 1972. 19p. (CONF-721062-8). Dep. NTIS (US Sales Only) $4.00.

From NUCLEX 1972: 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

In the HTR a high working temperature is achieved by use of a graphite core structure, ceramic-coated particle fuel and helium as coolant. Almost any combination of fissile and fertile fuel can be employed. It must therefore be expected that several different types of HTR will emerge and care must be taken not to confuse HTRs under development with systems which are already commercially viable. The development of the HTR is reviewed and its commercial breakthrough in the USA with cumulative sales of 5,400 MW(e) surveyed. Satisfactory production scale fuel for present day applications already exists. The basic forms of core design are examined–the pebble-bed system and the prismatic core. Some of the different particle designs in prismatic reactors are contrasted to illustrate the inherent flexibility of the HTR. The directions for future work on fuel are discussed. It is concluded that the main pressures will be to increase the operating margins, to reduce fabrication costs, simplify quality assurance and achieve greater overall optimisation. (auth)

**30163** (DP-Report-806) DRAGON REACTOR OPERATING EXPERIENCE. Dragon Project. Chapman, B. G. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Aug 1972. 22p. (CONF-721062-7). Dep. NTIS (US Sales Only) $4.25.

From NUCLEX 1972: 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

Although the primary purpose of the Dragon Reactor is to irradiate experimental HTR fuels, these activities generate a great deal of useful experience in operational areas such as helium utilisation, the design and maintenance of helium components and circuits, and the behavior of radioactive species. The paper describes this experience over the last six years. It is frequently difficult to predict the operational performance of large plants from the drawing board and the chief value of experience is to establish the practical limits which can be achieved. In this respect Dragon has demonstrated the viability of the HTR concept and enabled realistic design criteria to be laid down. (auth)

**30164** (DP-Report-814) MUPO NUCLEAR DATA LIBRARY 5. Dragon Project. Massimo, L.; Giesser, W.; Mancini, G. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Nov 1972. 30p. Dep. NTIS (US Sales Only) $4.50.

A description of the MUPO Library 5 at present used in the Dragon Project and in the European Community is given together with indications on its structure and limitations. A comparison between MUPO Library 3 and 5 has been carried out with special attention to those isotopes for which the discrepancies are bigger. (auth)

**30165** (GA-A-13026) PREIRRADIATION REPORT: FUEL MATERIALS FOR P13R AND P13S IRRADIATION CAPSULES. Young, C. A.; Harmon, D. P. (General Atomic Co., San Diego, Calif. (USA)). Nov 1974. Contract AT(04-3)-167. 167p. Dep. NTIS $7.60.

The objectives, test variables, and the preirradiation evaluation of the fuel materials are described for capsules P13R and P13S which are the seventh and eighth in a series of irradiation tests conducted under the AEC sponsored HTGR Fuels and Core Development Program. Capsules P13R and P13S are designed to extend GAC's irradiation experience with reference type fuel by testing it under a wide range of irradiation conditions including thermal cycling and by evaluating a broad spectrum of property and process variables. (auth)

**30146** CONSTRUCTION STOP FOR THE WYHL NUCLEAR POWER PLANT. Energiewirtsch. Tagesfragen; 25: No. 4, 172-177(1975). (In German).

At the request of 4 communities and 6 private persons, the Freiburg administrative court has, by verdict dated 14th March 1975—VS II 26/75—re-established the suspensive power of the applicants' action against the 1st partial licence for the construction of Kernkraftwerk Sued, Block 1, in Wyhl. (HP/LN)

**30147** CONSTRUCTIONAL LAYOUT OF THE MUELHEIM-KAERLICH NUCLEAR POWER STATION. Peter, F. (Brown, Boveri und Cie A. G., Mannheim (F. R. Germany). Geschaeftsbereich Kraftwerke). Atomwirtsch., Atomtech.; 20: No. 5, 246-253(May 1975). (In German).

The construction concept emphasizes protection against external influences, complete separation of the nuclear and the conventional area, and sufficient redundance of all important structural components. The reactor building and the reactor auxiliary buildings together constitute a closed controlled area. The heavy components can be inserted into the containment at ground level. The thermal power is conducted into the water-steam loop by two straight-tube steam generators. A natural-draught cooling tower for recirculation of the cooling water is still in the planning stage. The turbo-generator set consists of a condensation turbine with three casings and a directly coupled 1,500 revolutions-generator. (GE)

**30148** STAGES IN PLANNING AND CONSTRUCTION OF THE MUELHEIM-KAERLICH NUCLEAR POWER STATION. Pracht, F. (Rheinisch-Westfaelisches Elektrizitaetswerk A. G., Essen (F. R. Germany). Kraftwerksplanung). Atomwirtsch., Atomtech.; 20: No. 5, 245-246(May 1975). (In German).

On October 23, 1972, RWE gave a letter of intent and on January 9, 1973 an order for the construction of a nuclear power plant on a turn-key basis to the consortium of BBC, BBR and Hochtief. The power plant in question was the Muelheim-Kaerlich nuclear power station with a pressurized-water reactor of a gross rating of 1,295 MW(e). After considerable delay of the project, the first building permit was issued to the builder-owner on January 15, 1975, and the constructional work on the building site started immediately afterwards. As the planning and constructional work has so far been carried out according to schedule and the consortium intends to keep the effects of the belated license as small as possible, the start-off of the plant will probably be in summer 1979 if the construction work is not interrupted. (GE)

**30149** LAYOUT OF THE MUELHEIM-KAERLICH REACTOR. Schatz, A. K. (Babcock-Brown Boveri Reaktor G. m. b. H., Mannheim (F. R. Germany)). Atomwirtsch., Atomtech.; 20: No. 5, 253-258(May 1975). (In German).

The BBR pressurized-water reactor is characterized by a dual-cycle plant. Its straight-tube steam generators employ the once-through principle to generate superheated steam. The basic unit of the steam generation system is the pressurized-water reactor developed by the American Babcock and Wilcox Company which has been adapted to the German construction and safety regulations without changes in its basic conception. The steam generation system has two parallel coolant loops—each with its own steam generator, two recirculating pumps, one hot and two cold lines. In the primary system, afterheat removal is only possible by natural circulation. The same standardized fuel elements are used for reactors of different power—205 fuel elements in Muelheim-Kaerlich. (GE)

**30150** BIBLIS NUCLEAR POWER-STATION AS SEEN FROM THE OPERATOR'S POINT OF VIEW. Eitz, A. W.; Dieterich, L. (Rheinisch-Westfaelisches Elektrizitaetswerk A. G., Essen (F. R. Germany)). Kerntechnik; 17: No. 4, 157-160(Apr 1975). (In German and English).

With the first feeding into the grid from Biblis on August 25, 1974, as well as with the attainment of its 100% power output an December 5, 1974, RWE's decision taken in 1969 to build a 1,200 MW nuclear power plant was justified. The expected technical problems related to the plant as well as to the grid were solved within the original estimates. Moreover, it became evident that the magnitude as well as the smooth handling of the project require standardization for erection as well as licensing purposes. (auth)

**30151** COMMISSIONING OF UNIT A OF THE BIBLIS NUCLEAR POWER STATION. Ritter, M.; Wienken, P. (Kraftwerk Union A. G., Erlangen (F. R. Germany)). Kerntechnik; 17: No. 4, 168-177(Apr 1975). (In German and English).

The interplay of all individual systems was checked during the subcritical hot trial operation phases. The numerous measurements and subsequent inspections showed that all the components satisfy the stipulated requirements. The first criticality was followed by zero-power trial operation during which a schedule of measurements pertaining to reactor physics was carried out. The performance of the complete plant in normal operation and in exigencies was checked by means of experiments during consecutive phases of power operation. (auth)

**30152** BIBLIS NUCLEAR POWER STATION. Energie; 27: No. 4, 95-105(Apr 1975). (In German).

A short description of the components of the Biblis nuclear power station is given. In addition to the heat flow diagram, the coolant cycle and the turbine control system, some details of construction and reactor safety are presented. (GE)

**30153** ORDER AGAINST GRAFENRHEINFELD REVERSED. Energiewirtsch. Tagesfragen; 25: No. 1/2, 51-58(1975). (In German).

On the decision of the Bavarian Administrative Court of November 22, 1974, the decision of the Wuerzburg Administrative Court of August 26, 1974 (ET 11/74, p. 587) ordering a stop of construction in the Grafenrheinfeld nuclear power station was reversed on the appeal of Bayernwerk AG and Kraftwerk Union AG. The costs, including the extrajudicial costs of the two companies under subpoena as witnesses, were awarded against the petitioner—the city of Schweinfurt. The value of matter in controversy was taxed at 50,000 DM. The substance of the opinion is given in the article. (GE)

**30154** STEAM POWER PLANT WITH A PRESSURIZED-WATER REACTOR AND SEVERAL STEAM GENERATORS HEATED WITH PRESSURIZED WATER. Kelp, F. (to Kraftwerk Union AG). German(FRG) Patent 2,351,678/A/. 24 Apr 1975. 11p. (In German).

5 figs.

The efficiency of steam generators in pressurized-water reactors is to be increased by step switches. A circuit diagram shows the steam cycle of the reactor up to the turbines. (GE)

## Power Reactors, Non-Breeding, Graphite Moderated

*Refer also to abstracts 30123, 30125, 30131, 30134, 30305, 30312, 30320, 30330, 30332, 30333, 30360, 30362, and 30440.*

**30155** (AERE-R-8065) METAL FISSION PRODUCT BEHAVIOUR IN HTR $UO_2$-COATED PARTICLE FUEL. Brown, P. E.; Brownsword, M.; Faircloth, R. L.; Inns, A. J.; Hooper, E. W. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jun 1975. 30p. Dep. NTIS (US Sales Only) $4.50. UK.

A discussion of metal fission product behavior in high temperature reactor coated fuel particles is presented, commencing with the release from the $UO_2$ kernel followed by diffusion in the pyrocarbon coatings. The discussion centres mainly on the four key fission products although the properties of some other metallic fission products will be mentioned briefly. Some evidence for the permeation of silicon carbide by strontium and silver under certain conditions is also presented. (auth)

**30156** (CONF-750928-1) ADVANCED NUCLEAR REACTORS. Trauger, D. B. (Oak Ridge National Lab., Tenn. (USA)). 1975. 7p. Dep. NTIS $4.00.

From nuclear power and applications in Latin America; Mexico City, Mexico (29 Sep 1975).

Advanced nuclear reactors are assumed to be those not yet in service commercially. Included in this discussion, therefore, are the High Temperature Gas-Cooled Reactor (HTGR), the Steam Generating Heavy Water Reactor (SGHWR), the Light Water Breeder Reactor (LWBR), the Liquid Metal Fast Breeder Reactor (LMFBR), the Gas-Cooled Fast Breeder Reactor (GCFBR), and the Molten Salt Breeder Reactor (MSBR). The light water, magnox, and heavy water CANDU reactors are not included. Design characteristics and development programs for each type are reviewed. (auth)

**30157** (CONF-751007-1) FISSION PRODUCT BEHAVIOR DURING OPERATION OF THE SECOND PEACH BOTTOM CORE. Malinauskas, A. P.; de Nordwall, H. J.; Dyer, F. F.; Wichner, R. P.; Martin, W. J.; Kolb, J. O. (Oak Ridge National Lab., Tenn. (USA)). 1974. 18p. Dep. NTIS $4.00.

From IAEA international meeting on gas-cooled reactors; Julich, F.R. Germany (13 Oct 1975).

The Peach Bottom high-temperature, gas-cooled reactor began operation June 1, 1967 and continued power production until October 9, 1969, accumulating 452 equivalent full power days (EFPD) operation. After reload, power production with Core 2

began July 14, 1970 and terminated October 31, 1974 after 899 EFPD operation. Surveillance of fission product release and behavior was intensified during Core 2 operation to permit a wider range of measurements to be made. In addition to monitoring the fuel element purge system and noble gas content of the coolant circuit, the program was extended to include measurements of radioactive and other condensible species (including dust) entering and exiting the core and steam generator, and of surface concentrations of gamma-emitting nuclides deposited on the primary coolant surfaces. These data, which were obtained over the operating period April, 1971-October, 1974, are summarized and discussed. The data demonstrate that cesium behavior in the coolant circuit during the first two-thirds of Core 2 life was primarily governed by cesium released during Core 1 operation. The data also indicate that whereas the steam generator surfaces attenuate molecular cesium concentrations in the coolant, the dust-borne component is remarkably persistent. Driver fuel elements were removed from the reactor after 384 EFPD, 701 EFPD, and at end of life. These fuel elements are at various stages of an intensive post-irradiation examination. Some of the axial and radial concentration profiles of fission products which have been obtained are likewise presented. Although these profiles indicate varied fission product behavior, the observations can in general be qualitatively described on the basis of the operational histories of the fuel elements. (auth)

**30158** (DP-Report-744) PRESENCE OF Ag-111 IN THE DRAGON PRIMARY COOLANT CIRCUIT. Dragon Project Report. Rowland, P. R ; Browning, W. E.; Hatton, D.; Harris, A. M. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Oct 1971. 17p. Dep. NTIS (US Sales Only) $4.00.

The helium coolant of the Dragon Reactor has been sampled to determine the radioactive species present in the gas. Active silver isotopes have been found in relatively large quantities when compared with the usual isotopes expected in the coolant gas. It is suggested that the silver originates from fission and is more readily released than iodine, caesium or inert gases. Possible release mechanisms for silver are suggested. 9 references. (auth)

**30159** (DP-Report-754) ESTABLISHMENT OF COMPLETE FISSION PRODUCT INVENTORIES FOR IRRADIATED FUEL ELEMENTS. Dragon Project. Hick, H.; Lammer, M.; Nabielek, H.; York, J. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). May 1971. 138p. Dep. NTIS (US Sales Only) $10.00.

By a combination of gamma-spectrometric measurements and theoretical calculations a complete and accurate fission product inventory can be established. The basic idea is to use the experimental results for Cs-137 and Cs-134, together with a knowledge of the irradiation history, as a guide to derive proper neutron flux input data for the computer calculations. The result is a fission product inventory of any desired degree of completeness. The accuracy is verified by observing good agreement between theoretical and experimental results for a number of fission products which can be determined accurately by gamma-spectrometry. Due to recent improvements and widespread application of Ge(Li)-detectors, the gamma-line data for fission products have dramatically increased in number and accuracy during the last year. By means of the gamma-line table and the computer program IRREL, a quantitatively reliable interpretation of even the weak gamma-lines in a complex fuel element spectrum is possible. The complete fission product inventory of irradiated fuel elements can therefore be reliably established on a routine basis by a few measurements with a Ge(Li)-spectrometer and supporting computer calculations. (auth)

**30160** (DP-Report-765) FLATTER: A ONE-DIMENSIONAL EQUILIBRIUM FUEL MANAGEMENT PROGRAMME FOR CONTINUOUSLY ON-LOAD REFUELLED HIGH TEMPERATURE REACTORS. Dragon Project. Pedersen, J. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Sep 1971. 24p. Dep. NTIS (US Sales Only) $4.25.

FLATTER is a one-dimensional program specifically designed for the calculation of equilibrium fuel management in on-load-refuelled, high temperature reactors. The program is made very fast by the adoption of an analytical burn-up subroutine which avoids the usual step-by-step burn-up calculation and instead at once calculates the equilibrium composition of fuel, when the feed composition is given. Since the neutron spectrum is very important in high temperature reactors, a fast spectrum calculation in 43 groups is incorporated in the program, which will be entered for each reactor region with the material composition of that region and the bucklings, obtained with an up to 7-group diffusion calculation. Consistency between the diffusion calculation and the parameters used in defining the spectrum in each region is ensured with repeated iterations between the spectrum and diffusion calculations. The program will flatten the power distribution according to one of the following options: "Self-flattening" in which the fuel is assumed to have a constant residence time, so that high flux regions get high burn-up, and low flux regions low burn-up and this will tend to flatten the power distribution due to the burn-up; "Enrichment-flattening" in which the feed enrichment of different core regions will be automatically adjusted until overall power flattening has been obtained; and "Burn-up-flattening" in which the burn-up of different core regions will be adjusted until the power flattening has been obtained. (auth)

**30161** (DP-Report-802) DRAGON OPERATIONS BRANCH TWENTY-SIXTH QUARTERLY PROGRESS REPORT, OCTOBER–DECEMBER 1971. Dragon Project Report. Mason, I. K. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jul 1972. 33p. Dep. NTIS (US Sales Only) $4.75.

**30162** (DP-Report–803) HTR FUELS AND THEIR FURTHER DEVELOPMENT. Dragon Project. Graham, L. W.; Price, M. S. T. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jul 1972. 19p. (CONF-721062-8). Dep. NTIS (US Sales Only) $4.00.

From NUCLEX 1972: 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

In the HTR a high working temperature is achieved by use of a graphite core structure, ceramic-coated particle fuel and helium as coolant. Almost any combination of fissile and fertile fuel can be employed. It must therefore be expected that several different types of HTR will emerge and care must be taken not to confuse HTRs under development with systems which are already commercially viable. The development of the HTR is reviewed and its commercial breakthrough in the USA with cumulative sales of 5,400 MW(e) surveyed. Satisfactory production scale fuel for present day applications already exists. The basic forms of core design are examined–the pebble-bed system and the prismatic core. Some of the different particle designs in prismatic reactors are contrasted to illustrate the inherent flexibility of the HTR. The directions for future work on fuel are discussed. It is concluded that the main pressures will be to increase the operating margins, to reduce fabrication costs, simplify quality assurance and achieve greater overall optimisation. (auth)

**30163** (DP-Report–806) DRAGON REACTOR OPERATING EXPERIENCE. Dragon Project. Chapman, B. G. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Aug 1972. 22p. (CONF-721062–7). Dep. NTIS (US Sales Only) $4.25.

From NUCLEX 1972: 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

Although the primary purpose of the Dragon Reactor is to irradiate experimental HTR fuels, these activities generate a great deal of useful experience in operational areas such as helium utilisation, the design and maintenance of helium components and circuits, and the behavior of radioactive species. The paper describes this experience over the last six years. It is frequently difficult to predict the operational performance of large plants from the drawing board and the chief value of experience is to establish the practical limits which can be achieved. In this respect Dragon has demonstrated the viability of the HTR concept and enabled realistic design criteria to be laid down. (auth)

**30164** (DP-Report–814) MUPO NUCLEAR DATA LIBRARY 5. Dragon Project. Massimo, L.; Giesser, W.; Mancini, G. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Nov 1972. 30p. Dep. NTIS (US Sales Only) $4.50.

A description of the MUPO Library 5 at present used in the Dragon Project and in the European Community is given together with indications on its structure and limitations. A comparison between MUPO Library 3 and 5 has been carried out with special attention to those isotopes for which the discrepancies are bigger. (auth)

**30165** (GA-A-13026) PREIRRADIATION REPORT: FUEL MATERIALS FOR P13R AND P13S IRRADIATION CAPSULES. Young, C. A.; Harmon, D. P. (General Atomic Co., San Diego, Calif. (USA)). Nov 1974. Contract AT(04-3)-167. 167p. Dep. NTIS $7.60.

The objectives, test variables, and the preirradiation evaluation of the fuel materials are described for capsules P13R and P13S which are the seventh and eighth in a series of irradiation tests conducted under the AEC sponsored HTGR Fuels and Core Development Program. Capsules P13R and P13S are designed to extend GAC's irradiation experience with reference type fuel by testing it under a wide range of irradiation conditions including thermal cycling and by evaluating a broad spectrum of property and process variables. (auth)

**30166** (GA-A-13167) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1974. (General Atomic Co., San Diego, Calif. (USA)). 31 Oct 1974. Contract AT(04-3)-633. 108p. Dep. NTIS $5.45.

The continuation of the series describing the research and development program for the Public Service Company of Colorado 330-MW(e) High-temperature Gas-cooled Reactor is described. The work reported here includes studies of nuclear analysis and power shaping. The fuel development and fuel element proof testing portions of the report include demonstration testing of the performance of test fuel elements by means of irradiation at expected operating temperatures and capsule irradiation tests of production fuel. (auth)

**30167** (GA-A-13206) COMPONENT AND SYSTEMS DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1974. (General Atomic Co., San Diego, Calif. (USA)). 8 Nov 1974. Contract AT(04-3)-167. vp. Dep. NTIS $4.00.

Information is presented concerning fatigue and creep studies on HTGR materials, helium effects studies, and thermal barrier studies. (DCC)

**30168** (GA-A-13265) PREIRRADIATION REPORT FUEL MATERIALS FOR IRRADIATION P13Q. Smith, C. L. (General Atomic Co., San Diego, Calif. (USA)). 13 Jun 1975. Contract AT(04-3)-167. 81p. Dep. NTIS $5.45.

The purpose of P13Q is to evaluate the performance of LHTGR fresh fuel irradiated in integral bodies under nominal LHTGR operating conditions. The test was designed to operate at a constant peak centerline temperature of 1150°C to fast neutron exposures in the range $6 \times 10^{21}$ to $9 \times 10^{21}$ n/cm$^2$ (E greater than or equal to 0.18 MeV/sub HTGR/). The capsule contains 18 fuel rods. Sixteen of the rods were fired using the cure-in-place process, removed from their graphite firing containers for QC evaluation, and placed in P13Q bodies for irradiation. The capsule bodies were used as fuel rod firing containers; consequently, the test will be used to evaluate the integral performance of LHTGR-type graphite and fuel rods fabricated by cure-in-place. For comparison, two fuel rods fired in packed alumina beds were also included. One batch of TRISO $UC_2$ fissile and two batches of BISO fertile fuel particles were used in the fuel rods. In addition, each rod contains isotropic graphite shim particles. 4 references. (auth)

**30169** (GA-A-13301) GAS TURBINE HTGR PROGRAM. Quarterly Progress Report for the Period October 1, 1974–December 31, 1974. (General Atomic Co., San Diego, Calif. (USA)). 31 Jan 1975. Contract AT(04-3)-167. 149p. Dep. NTIS $7.60.

This AEC-supported work includes engineering and development of the gas-turbine high-temperature gas-cooled reactor (GT-HTGR) with respect to the steady and transient performance, safety, and maintainability of the system; technology development for certain major components such as the primary pressure boundary and turbomachinery; R and D on materials and fission product effects; and the requirements imposed by the GT-HTGR on the Helium Component Test Facility (HCTF). (8 references) (auth)

**30170** (GA-A-13332) FINAL TEST OPERATIONS REPORT: CAPSULE P13P. Wattier, J. B. (General Atomic Co., San Diego, Calif. (USA)). 31 Jul 1975. Contract AT(04-3)-167. 503p. Dep. NTIS $13.60.

A capsule containing fuel specimens and core materials was inserted into the J-10-SE position of the Engineering Test Reactor core at the Aerojet Nuclear Company, Idaho Falls, Idaho, on April 1, 1972. The irradiation part of the experiment was completed on April 30, 1973. The capsule received a peak fast fluence (E greater than 0.18 MeV)/sub ETR/ of $8.1 \times 10^{21}$ n/cm$^2$ and a peak thermal fluence of $3.1 \times 10^{21}$ n/cm$^2$. The primary specimens irradiated in capsule P13P were fuel rods and unbonded beds of coated fuel particles. The samples contained $UC_2$, $UO_2$, (Th, U)$O_2$, $ThO_2$, and $ThC_2$ TRISO- and BISO-coated particles with variations in coating density and process parameters. The test specimens were housed by interlocking graphite crucibles inside inconel cans which formed the primary containment for each cell. Five cells were arranged vertically in a stainless steel tube. The thermal, neutronic, and operating histories of the P13P capsule presented delineate the environmental conditions to which the fuel samples were subjected. Tungsten-rhenium thermocouples were placed in the vicinity of the fuel samples to monitor the cell temperature and to provide data for estimating peak fuel temperatures. Temperatures in the graphite were measured by both tungsten-rhenium and chromel-alumel thermocouples. (auth)

**30171** (GA-A-13492) DISC CATCHER DESIGN FOR THE GAS TURBINE HIGH-TEMPERATURE GAS-COOLED REACTOR. Chmielewski, R. D.; Vepa, K. (General Atomic Co., San Diego, Calif. (USA)). 30 Jun 1975. Contract AT(04-3)-167. 45p. Dep. NTIS $4.00.

The gas turbine HTGR power plant combines a nuclear core having an established design with three power conversion loops. Each power conversion loop contains a helium gas turbine driving a helium compressor and electrical generator, a recuperative heat exchanger, and a helium-to-water precooler. The potential failure modes of the turbomachine have been investigated to evaluate requirements for missile protection. The state-of-the-art methods available for the design of disc catchers are reviewed. Preliminary sizing of the shield using various materials is discussed, along with potential disc fragments and energies, failure probability of steam turbine and aircraft engines, and analysis of potential concrete penetrations for postulated disc fragments. 42 references. (auth)

**30172** (GA-A-13512) COMPONENT AND SYSTEMS DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1975. (General Atomic Co., San Diego, Calif. (USA)). 31 Jul 1975. Contract AT(04-3)-167. 51p. Dep. NTIS $5.45.

Information is presented concerning fatigue and creep-fatigue studies on HTGR materials, helium effects studies, and thermal barrier attachment fixture fatigue program. (DCC)

**30173** (INIS-mf-1640, pp 25-36) BEHAVIOUR OF IODINE SPECIES IN THE WINDSCALE AGR. Hillary, J. J. (UKAEA Reactor Group, Sellafield). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973). (Commission of the European Communities, Brussels (Belgium)).

Iodine-131 has been released into the coolant of WAGR from a number of deliberately or operationally defected fuel pins. This iodine has been found principally in the form of methyl iodide and, based on the majority of the results, has a chemical decomposition half-life, due to plate-out during passage round the gas circuit, of about 2½ min. Methyl iodide which was injected separately into the circulating coolant was found to have a similar half-life. The ratio of the steady state iodine-131 release from the fuel to that remaining gas borne was found to be 4,500. The deposition of iodine has been observed on the cooler surfaces of the heat exchangers. The deposition velocity, corresponding to a 2½ min half-life, for these heat exchanger surfaces was 0.02 cm/sec. (INIS)

**30174** (JUL-1180) APPLICATION OF HIGH TEMPERATURE REACTORS IN IRON AND STEEL INDUSTRY: WITH CONSIDERATION OF INFLUENCES ON LOCATION AND ENVIRONMENT. Manthey, C. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)). Mar 1975. 114p. (In German). Dep. NTIS (US Sales Only) $8.75.

Thesis. Submitted to Technische Hochschule, Aachen.

High temperature reactors are able to supply the energy necessary for iron technology in the form of process heat for generating reduction gas from fossil raw materials or water and steam for electricity generating purposes. For the present the most promising mode of utilizing the HTGR in the iron and steel industry seems to be the non-integrated application. The locations of the reactors depend on the optimal location for reduction gas generation. The gas will be delivered to the metallurgical plants through a piping system. The electricity produced by the HTGR could be fed into the local electrical grid. An existing hydrogen distribution system is assumed together with the possibility of direct ore reduction with hydrogen. For the direct reduction process a shaft furnace is chosen. The economy of reactor application is investigated and potential use till the year 2000 is estimated. The effects of HTGR application on location and environment of iron and steel industry are described. (auth)

**30175** (JUL-1184) MODEL ANALYSIS OF INFLUENCES OF HIGH-TEMPERATURE REACTOR ON LOCATION SHIFTING IN CHEMICAL INDUSTRY. Schwarz, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)). Apr 1975. 266p. (In German). Dep. NTIS (US Sales Only) $16.50.

Thesis.

An analysis is presented of the influences of the high-temperature reactor on probable site shifting of big chemical plants. A spatial location model is employed which includes an investigation of 116 industrial locations within the first six nations of Common Market. Computer calculations show differences in site qualities when traditional or nuclear energy systems are considered. In addition to the energy factor some other important factors such as subsidies, taxes, labor, and transport costs are analysed, and their influence on industrial site selection is quantified. (auth)

**30176** (JUL-1185) DISTURBANCE OF THE COOLING-GAS DISTRIBUTION IN BLOCK SIZED FUEL ELEMENTS DUE TO BY-PASS FLOW. Groehn, H. G. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorbauelemente). Apr 1975. 67p. (In German). Dep. NTIS (US Sales Only) $6.50.

Thesis.

The effect of the by-pass flow upon the main flow through the cooling channels of a model of a HTR fuel element is described. The bypass flow was introduced through a wedge shaped gap located between two succeeding fuel element models. The model scale was 1 : 1. The gap width was varied between 1,85 and 6 mm. A blockage for the entrance area for the bypass flow was provided such as the entire circumference, one half or one sixth was left open. The Reynolds number with regard to the cooling channel of the fuel element was $1.5 \times 10^4 < Re_K < 6.5 \times 10^4$. A relationship between the flow resistance of the wedge shaped gap and the Reynolds number is given. Equations are presented for the effect of varying bypass flow on the distribution of the main flow through the cooling channels. (auth)

**30177** (JUL-1191) COMPARATIVE STUDY FOR ENERGY SUPPLY WITH NUCLEAR DISTRICT HEATING AND WITH NUCLEAR LONG DISTANCE ENERGY. Dietrich, G. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)). Jul 1975. 169p. (In German). Dep. NTIS (US Sales Only) $11.50.

Thesis. Submitted to Technische Hochschule, Aachen.

The future energy supply of the Federal Republic of Germany will be orientated to reliable energy carriers. Economical energy consumption and environmental protection will be a force for an increased application of district heating and nuclear long distance energy. The techniques of generation, transport, and distribution of the two energy carriers are discussed, and a short review of application areas and potentials is presented. The cost comparisons by models show that there are special advantages for both systems. It is concluded that nuclear long distance energy is favored because of its wide application range in the whole heat market. There is also the competition with combined heat and power generation from fossil basis, as practised by many industries. As a result of a regional analysis of the area Aachen Monchengladbach–Koln, the cost advantages of the nuclear long distance energy as a parameter of current prices are confirmed. Nuclear long distance energy, in combination with the high temperature reactor and a technique employing catalysts up to temperatures of 900 K, is an energy source which will be, independent of regional necessities, reliable, non-polluting, and economical. (auth)

**30178** (JUL-1198) NUMERICAL INVESTIGATIONS FOR A NEW REFUELING SCHEME FOR HTR WITH PRISMATIC FUEL ELEMENTS UNDER OPERATING CONDITIONS OF A HELIUM TURBINE-POWER PLANT. Biele, B. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Projekt Hochtemperaturreaktor mit Heliumturbinen). Jun 1975. 94p. (In German). Dep. NTIS (US Sales Only) $7.75.

Thesis. Submitted to Technische Hochschule, Aachen.

The effort to get highest gas exit temperatures in connection with lowest fuel element temperatures in a high temperature gas-cooled reactor with prismatic fuel elements (HTGR) requires a special refueling scheme. The "axial pushthrough" is such a refueling scheme. The neutronphysical and thermodynamic properties of a HTGR-core with pushthrough-fuel-management is investigated. It can be shown that a core with a high heavy metal content and pressed fuel elements (monolith) with the geometry of the Fort St. Vrain fuel elements has the most favorable properties. A detailed core study, where burnable poison and control rod movements were treated, shows that the pushthrough-refueling makes it possible to reach highest gas exit temperatures in connection with lowest fuel element temperatures in a HTGR with prismatic fuel elements. (auth)

**30179** (JUL-1201) ENGINEERING SOLUTIONS FOR A REFLECTOR CHANGE CONCEPT IN THE HIGH-TEMPERATURE REACTOR WITH PEBBLE BED CORE AND OTTO-FUELING. Kasper, K. J. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Nuklear Sicherheitsforschung). Jun 1975. 152p. (In German). Dep. NTIS (US Sales Only) $10.75.

Thesis. Submitted to Technische Hochschule, Aachen.

In the field of reactor engineering an increasing tendency is visible towards a "repairable reactor." In the construction of the HTR with spherical fuel elements this fact should already be taken into account at an early stage. Additionally it is possible that connection with OTTO-fueling load conditions for the graphite reflector could result which are locally not far from limiting values. Therefore the removability of the reflector is included in the reactor construction as an accompanying technical step of the physical lay-out of the core. The core arrangements, realized for HTR until recently, are discussed as well as the properties of the graphites used and the operating conditions of the reactor. In the case of the PR 3000 proposals are offered for the construction of a removable side and top reflector for a pebble bed reactor. A solution was found which allows the changing of the reflector and requires no significant increase of the costs for the reactor assembly. The requirements of reactor operation and of repairability are satisfied in an optimal manner. (auth)

**30180** (JUL-1205) FISSION PRODUCT BEHAVIOR IN HTR SPHERICAL FUEL ELEMENTS WITH DAMAGED FUEL PARTICLES. Duwe, R.; Groos, E.; Ragoss, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jun 1975. 39p. (In German). Dep. NTIS (US Sales Only) $5.00.

HTR fuel elements containing various amounts and types of defective particles were irradiated in three in-pile experiments in order to test two methods for the identification of fuel elements with enhanced fission gas release. With the fission gas annealing method by measuring the initial burst, fuel elements with 1% defective particles could be identified within less than three minutes measuring time. The nondestructive gammaspectrometric method rendered possible the detection of $^{137}Cs$ diffused into the fuel free zone of the fuel spheres, however, measuring times of more than one hour were required. 14 references. (auth)

**30181** (ORNL-tr-4002) GASIFICATION OF COAL WITH NUCLEAR PROCESS HEAT. Feasibility and Technico-Economic Prospects of Coal Gasification with Nuclear Heat from High-Temperature Reactors. Jul 1974. Translation by R. G. Mansfield of German Report. 101p. Dep. NTIS $8.25.

The objective of the present study is to predict, by establishing planning data, the prospects of nuclear process heat as accurately as possible and to present the elements of a development program for solving the still unresolved technical problems. Specifically, in setting up the planning data, the following were considered: further development of the high-temperature reactor with spherical fuel elements for helium outlet temperatures of 950°C, and design and study of various systems for rerouting the high-temperature heat; design and study of selected chemical engineering processes for hydrogenation coal gasification as well as for steam gasification of coal with heat from high-temperature helium; layout of integrated plants of various sizes in which different processes are used for producing various gases, coupling-on of a plant for direct reduction of iron ore; calculation of the plants under study and determination of the costs of the products; and presentation of predicted energy supply and demand, studies on marketing, and environmental and siting problems. (auth)

**30182** GAS TURBINES. Dietzel, F. Energie; 27: No. 4, 107-109(Apr 1975). (In German).

The development of gas turbines in different fields of application up to the most recent constructional types is described. (GE)

**30183** POTASSIUM/STEAM CYCLE OF A HIGH-EFFICIENCY NUCLEAR POWER PLANT WITH A GAS-COOLED REACTOR. Collier, J. G.; Cox, R. F.; Evans, L. S.; Bainbridge, G. R. (British Insurance (Atomic Energy) Committee, London; Newcastle upon Tyne Univ. (UK)). Arch. Energiewirtsch.; 29: No. 2, 124-134(Feb 1975). (In German).

2 figs.; 4 tabs.; 1 ref.

On the basis of a short description of the Rankine cycle with water and potassium as the working medium, the technical problems connected with the use of this coolant in a high temperature reactor are described along with their solutions. The cost situation and the advantages and disadvantages of the potassium-steam and the pure steam cycle are also mentioned. (GE)

**30184** HELIUM GAS TURBINE PLANT IN OBERHAUSEN: A MILESTONE FOR THE DEVELOPMENT OF HIGH-TEMPERATURE REACTORS. Griepentrog, H. M.A.N. (Maschinenfabr. Augsb.-Nuernb.) Forsch., Planen, Bauen; No. 6, 4-10(1975). (In German).

The 50 MW helium turbine from the GHH Sterkrade for the new thermal power plant of Energy Supply, Oberhausen (EVO), works according to the method of closed cycles proposed in 1939. In this closed gas turbine method, the working medium does not take part in the combustion, but is heated from the outside in a superheater. After the heated medium has given off its energy, it must be cooled down again in an after-cooler so that the power will not be too great when compressing the circulating medium. A future field of application of the gas turbine in closed cycle is the direct coupling with helium cooled high temperature reactors for over 1000 MW electric power. Layout and construction of the turbine plant are described. (GE)

**30185** CHEMICAL BEHAVIOR AND IMPROVED RETENTION OF FISSION PRODUCTS IN IRRADIATED HTGR FUELS. Foerthmann, R.; Gruebmeier, H.; Kleykamp, H.; Naoumidis, A. (Kernforschungsanlage, Juelich, Ger.). pp 147-162 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol. 1); CONF-741030-P1.

Electron microprobe analysis on irradiated coated particles with high burn-ups (50% FIMA) gives detailed information on the chemical state and the transport behavior of solid fission products. Metallic fission products form different types of Mo–Tc–Ru–Rh and Pd–Te inclusions; oxide forming fission products are precipitated as compounds, e.g., $(Sr,Ba)ZrO_3$, or form solid solutions with the oxide kernel matrix (rare earths, Sr, Zr). Cesium is preferentially deposited in fission gas pores. Fission product inclusions could not be detected in carbide fuel kernels. Corresponding to the chemical state in the kernel, the following fission products are released easily from the kernel and diffuse through the entire pyrocarbon coating: cesium, strontium, barium, and palladium, and, in addition, from carbide kernels, the rare earths. These fission products can be retained by a silicon carbide layer. A first irradiation experiment demonstrates the possibility of increasing the kernel retention by changing the chemical state of solid fission products. By electron microprobe analysis, a strong chemical reaction was shown to occur between additional oxide inclusions consisting of an alumina-silica mixture and the fission products cesium, strontium and barium in the kernel. The best gettering effect was observed at $1 < Si/Al < 3$, probably corresponding to the formation of the compounds $CsAlSi_2O_6$ and $(Sr,Ba)Al_2Si_2O_8$ in the inclusions. Consequently, post-irradiation annealing experiments result in a reduction of the cesium release from pyrocarbon-coated fuel particles, by more than two orders of magnitude, if the kernel contains alumina-silica additives. (auth)

**30186** ANALYSIS AND MEASUREMENT OF MASS TRANSPORT IN COATED $UO_2$ AND OTHER HTGR OXIDE PARTICLES. Lindemer, T. B.; de Nordwall, H. J.; Olstad, R. A. (Oak Ridge National Lab., TN). pp 163-171 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

Fuel kernel migration is widely observed in the coated oxide and carbide fuel particles used in high-temperature gas-cooled reactors (HTGRs). The rate of this phenomenon is generally observed to be sufficient to establish operational limits on the time-temperature-power density relationships needed for the design of the HTGR core. On the other hand, it has been difficult to establish the rate-controlling migration mechanism in oxide fuels and thus permit the rate of this mechanism to be determined unequivocally. New and general theoretical methods that can be used to establish experimentally the rate-controlling mechanism are described. These developments are applied to the analysis of recent in-reactor kernel migration observed in coated $UO_2$, Th/sub 1-z/U/sub z/$O_2$, and $ThO_2$ particles. Results of the analysis show that the kernel migration rate is apparently not controlled by the rate of $CO/CO_2$ diffusion in $UO_2$, Th/sub 1-z/U/sub z/$O_2$, or $ThO_2$ particles. Furthermore, the data indicate that a solid-state diffusion mechanism is controlling the kernel migration rate. A solid-state kernel migration coefficient (KMC) has been calculated for each particle observed in metallographic cross-sections of specimens from several irradiation experiments. The KMC is defined as $(y/t)(T^c)(dT/dx)^{-1}$, in which y is the observed migration during time t. These coefficients were obtained over the temperature range 900 to 2000°C. The KMC for $ThO_2$ was less than that for Th/sub 1-z/U/sub z/$O_2$ at a given temperature; $UO_2$ had the highest KMC at T less than or equal to 1200°C. The activation energy for the $UO_2$ KMC was approximately 19 kcal/mol, while that for $ThO_2$ and Th/sub 1-z/U/sub z/$O_2$ was approximately 44 to 45 kcal/mol. No burn-up dependence of the KMC could be discerned in either $ThO_2$ or $UO_2$. (auth)

**30187** STUDIES ON THE AMOEBA EFFECT: CARBON TRANSPORT IN COATED FUEL PARTICLES UNDER THE INFLUENCE OF A TEMPERATURE GRADIENT. Naoumidis, A.; Thiele, B. (Kernforschungsanlage, Juelich, Ger.). pp 173-186 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

The amoeba effect in coated carbide and oxide fuel particles has been analyzed and proposals for stabilizing the two types of particles have been made. In a series of out-of-pile measurements, the stabilizing effect of nitrogen doping in $UC_2$ or substitution of the $UC_2$ phase by U(C,N) or (U,Zr)(C,N) phases could be demonstrated. In pile, a number of fuel particles having different kernel compositions were irradiated. The quantitative evaluation of this test has shown that the susceptibility of oxide particles to amoeba attack can essentially be reduced by doping with small amounts of carbide, which getters excess carbon monoxide. (auth)

**30188** EXPERIMENTAL-INDUSTRIAL NUCLEAR POWER PLANT BRIG. Krasin, A. K.; Nesterenko, V. B.; Kovalev, S. D.; Bubnov, V. P.; Bunin, E. N.; Mirgorodskii, V. S.; Il'in, A. Ya.; Tverkovkin, B. E.; Naumov, V. A.; Slizov, V. P.; Kukhaev, A. I.; Sharovarov, G. A. (Inst. of Nuclear Power Engineering, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk; No. 2, 5-13 (1975). (In Russian).

Technical specifications are proposed. The thermal scheme, reactor performance, and cooling circuit equipment are listed. The complete set of questions concerning nuclear and chemical safety and plant installation are considered as well as the simultaneous possibility of reactor utilization with heating capacity ranging from 250 to 350 MW as reactor turning out auxiliary nuclear fuel and as the source for electric-power production and for introduction of district heating plants. (auth)

**30189** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Smith, P. M. (to British Nuclear Design and Construction Ltd.). British Patent 1,396,499/B/. Jun 1975. Filed date 7 Dec 1971. 7p.

Reference is made to reactors of the type having a core composed in part of columns of moderator material, notably gas cooled reactors. It is desirable with such reactors to make provision for removal of the blocks of moderator material that compose the columns in order that any desired changes can be made to the design even after completion of construction. A major problem is the difficulty of providing sufficient lateral restraint for the columns while still permitting the blocks to be easily withdrawn, and avoiding undue restraint forces which would make the blocks difficult to remove. Build-up of lateral restraint forces between abutting columns can result from slight lateral dimensional differences between the columns, so that when a slightly oversize column is surrounded by smaller columns that bear on it but not on each other what is called a "nipping" load occurs on the oversize column. An arrangement is described to prevent the build-up of such loads by incorporating elasticity into the abutment of adjacent columns. This may be achieved by provision of resilient means, such as leaf springs or resilient tongues. (UK)

## Power Reactors, Non-Breeding, Otherwise Moderated

*Refer also to abstracts 30156, 30323, 30435, and 30436.*

**30190** (AECL-5125) NUCLEAR MATERIALS: PROSPECT AND RETROSPECT. Perryman, E. C. W. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Apr 1975. 25p. Dep. NTIS (US Sales Only) $4.00. AECL $1.00.

The impact that materials have had on the development of the CANDU reactor system is reviewed. Zirconium technology, for example, has been and continues to be an important part of the Canadian nuclear power program and a description is given of the development of the first Zircaloy-2 pressure tubes and the development of subsequent alloys for pressure tubes and fuel cladding. Emphasis is laid on the importance of reliability of components and systems and the part that materials have played in achieving high production capacity for both CANDU reactors and heavy water plants is described. Likely materials requirements for future systems involving plutonium recycling, fusion or electrical breeding are discussed. (auth)

**30191** (AED-CONF-73-415-002) NUCLEAR CODE REQUIREMENTS FOR NDT INCLUDING PERIODIC INSPECTION. Nixon, E. G. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects). 1973. 13p. (CONF-7309142-1). INIS.

From 4th conference on nondestructive welding; Toronto, Ontario, Canada (18 Sep 1973).

Nuclear code requirements for non-destructive examination (which does not affect or put stress of any kind on the material or component, as opposed to testing, which does) are outlined as they pertain to the CANDU reactor concept. The ASME nuclear code is written primarily for the U. S. light water reactors, and its deficiencies with regard to plates, forgings, tubes and welds are pointed out. Personnel factors such as certification and requali-

fication are discussed. The problems of inservice inspection are weighed against its necessity. (INIS)

**30192** (AED-CONF-73-562-003) SCANNING ELECTRON MICROSCOPY AND ENERGY DISPERSIVE X-RAY MICROANALYSIS OF NUCLEAR REACTOR CORROSION PARTICLES. Wikjord, A. G.; Mayor, G. H.; Doern, F. E. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). [nd]. 24p. (CONF-731173-1). INIS.

From symposium on water quality parameters-selection, measurement and monitoring; Burlington, Ontario, Canada (19 Nov 1973).

The nature and origin of particulates in the heat transport system of CANDU (Canada Deuterium Uranium) water-cooled nuclear reactors are relevant to the operation of these stations. The analysis of corrosion particles is difficult because of their small size and low concentration. A scanning electron microscope equipped with an x-ray analyzer has been used successfully for the simultaneous characterization of the morphology, size and elemental composition of these particles. In this study, individual particles having masses as low as $10^{-15}$ grams have been analyzed and x-rays arising from electron capture decay of $^{55}Fe$ have been observed in some of the samples. The techniques discussed are potentially applicable to a variety of problems related to the quality of environmental waters. (INIS)

**30193** CARBON-14 INTAKES DURING NON-ROUTINE OPERATIONS AT PICKERING GENERATING STATION. Bieber, C.; Wong, K. Y. (Ontario Hydro Research Lab., Toronto). Health Phys.; 29: No. 2, 349-350(Aug 1975).

At the CANDU type reactors at the Pickering Generating Station, Canada, the non-routine leakage, venting, and purging of the annulus $^{14}N_2$ gas, which undergoes (n, p) reaction to form $^{14}C$, on a number of occasions has led to personnel being exposed to low levels of airborne $^{14}C$. Urine samples of personnel operating the station are routinely analysed. Occasions when these samples indicated the presence of a volatile pure $\beta$ emitter which was recognised to be $^{14}C$ are cited. The excretion rate of one individual was monitored from which the effective elimination half-life of the $^{14}C$ was found to be 0.57 days in good agreement with the ICRP value. (UK)

**30194** GENERAL AND DESIGN REQUIREMENTS FOR CANDU NUCLEAR POWER PLANT COMPONENTS. Rexdale, Ontario; Canadian Standards Association (1974). 141p.

General requirements for Classes 1, 2, 3, and 4 components and design requirements for Classes 1, 2, and 3 components which are within the scope of ASME Section III Code are described. The code of which this Standard forms a part is intended to supplement the ASME Boiler and Pressure Vessel Code insofar as CANDU nuclear power plant components are concerned. (CA)

**30195** NATURAL URANIUM HEAVY WATER REACTORS FOR DESALINATION: A COMPARISON BETWEEN THE FUEL PIN AND FUEL CLUSTER CONCEPTS. Fouad, H. Y. (Atomic Energy Authority, Cairo). IEEE (Inst. Electr. Electron. Eng.) Trans. Nucl. Sci.; NS-22: No. 4, 2001-2005(Aug 1975).

Studies on the potential use of nuclear desalination in Egypt have been conducted. The choice of reactor type and system concept was influenced by emphasis on relaxed technological conditions so as to fit local circumstances. Natural uranium heavy water reactors were found promising. Finer details of type of fuel, cladding, coolant, and system arrangement were left for comparative studies. The question of fuel type, fuel pin versus fuel cluster, was considered. Simplified analytical and computational techniques were adopted and results verified with published criticality measurements. Results are given for a typical 40 MW(t) project study showing core features and system characteristics. 8 references. (auth)

## Power Reactors, Breeding

*Refer also to abstracts 27669, 27992, 28453, 28485, 28486, 28489, 28652, 30131, 30156, 30235, 30307, 30309–30316, 30331, 30336–30338, 30368, 30369, 30375, 30382, 30384, and 30437–30439.*

**30196** (AERE-R-8012) MODELLING FISSION GAS RELEASE AND SWELLING IN FAST REACTOR FUEL PINS. Wood, M. H.; Hayns, M. R. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jul 1975. 48p. Dep. NTIS (US Sales Only) $5.50. UK pounds 1.50.

Investigations into the mechanisms involved in the release of fission product gases from fast reactor fuel elements have been made. A rate theory model of the homogeneous nucleation and subsequent growth of fission gas bubbles has been developed which allows the inclusion of bubbles containing in excess of $10^6$ atoms. Various processes which influence the growth of the intragranular bubbles and hence the release to grain boundaries have been included in the model. Bubble migration and coalescence are shown to be essential in order to bring the amount of gas release into line with experimental observations. The effects of fission gas resolution rate, gas atom diffusivity, grain size, temperature, and binary nucleation coefficient have been investigated, and it is concluded that the dominant parameters for gas release are temperature, grain size, re-solution rate, and bubble migration and coalescence. (auth)

**30197** (ANL-CT-76-7) ACOUSTICALLY DETECTED EVENTS DURING TREAT TEST R7. Anderson, T. T.; Gavin, A. P.; Spencer, B. W.; Holtz, R. E. (Argonne National Lab., Ill. (USA)). Jul 1975. 26p. AT.

The ANL-developed Type HT-9 microphone performed successfully during the TREAT Test R7 and contributed useful test information. It evidenced no detectable response to radiation from the reactor environment; however, some signal loss was experienced for which an explanation is being sought. The data illustrate several features of the test sequence as follows: (a) opening of the sodium flow valve at 6.0 sec; (b) sodium flow noise from 6.5–19.5 sec; (c) discrete sounds of mechanical origin with a background of diminishing flow noise during the thermal transient, 19.5–28.5 sec; (d) sodium boiling from 28.5–30.0 sec (followed by signal loss to 32.0 sec); and (e) various other events in the latter experiment stages including, qualitatively, "gurgling" due to rise of gas bubbles into the upper plenum. (auth)

**30198** (ANL-CT-76-8) SIGNAL ANALYSIS METHOD USING THE CROSS-CORRELATION OF TURBULENCE FLOW SIGNALS TO DETERMINE CALIBRATION OF PERMANENT MAGNET SODIUM FLOWMETERS. Raptis, A. C.; Forster, G. A. (Argonne National Lab., Ill. (USA)). Jul 1975. 24p. AT.

A method is described of in-place calibration that may be applied while the flowmeter is performing its normal function. The calibration of a permanent magnet flowmeter depends directly on its magnetic field strength which can drift with time and temperature. The cross-correlation technique (CCT) involves determining the cross-correlation function of the time varying signals from two sets of electrodes spaced along the flow channel of a permanent magnet flowmeter. These electrode sets are similar to the ones normally used to obtain the flow signal. (auth)

**30199** (ANL/CT-76-13) DYNAMICS OF A COUPLED SHELL/FLUID SYSTEM. Chen, S. S.; Rosenberg, G. S. (Argonne National Lab., Ill. (USA)). Aug 1975. 31p. Dep. NTIS $4.50.

A study of two concentrically located circular cylindrical shells containing and separated by fluids is presented. An exact frequency equation is derived for the general case and an approximate closed-form solution is obtained for the shell system with an incompressible fluid. It is found that the lowest frequency of the coupled system is associated with one of the out-of-phase modes, and is lower than the frequencies of the individual shells. (auth)

**30200** (ANL/EBR-089) WATER TREATMENT IN THE EBR-II STEAM SYSTEM. Klein, M. A.; Hurst, H. (comps.). (Argonne National Lab., Idaho Falls, Idaho (USA)). Jan 1975. 48p. Dep. NTIS $5.50.

Boiler-water treatment in the EBR-II steam system consists of demineralizing makeup water and using hydrazine to remove traces of oxygen and morpholine to adjust pH to 8.8–9.2. This treatment is called a "zero-solids" method, because the chemical agents and reaction products are either volatile or form water and do not contribute solids to the boiler water. A continuous blowdown is cooled, filtered, and deionized to remove impurities and maintain high purity of the water. If a cooling-water leak occurs, phosphate is added to control scaling, and the "zero-solids" treatment is suspended until the leak is repaired. Water streams are sampled at six points to control water purity. Examination of the steam drum and an evaporator show the metal surfaces to be in excellent condition with minimal corrosion. The EBR-II steam-generating plant has accumulated over 85,000 hours of in-service operation and has operated successfully for over ten years with the "zero-solids" treatment. (auth)

**30201** (CONF-751007-2) VENTED FUEL EXPERIMENT FOR GAS-COOLED FAST REACTOR APPLICATION. Longest, A. W.; Gat, U.; Conlin, J. A.; Campana, R. J. (Oak Ridge National Lab., Tenn. (USA); General Atomic Co., San Diego, Calif. (USA)). 1975. 18p. (SM-200/47). Dep. NTIS $4.00.

From IAEA international meeting on gas-cooled reactors; Julich, F. R. Germany (13 Oct 1975).

A pressure-equalized and vented fuel rod is being irradiated in an instrumented capsule designated GB-10 to approximately 100 MWd/kg-heavy metal. The fuel is a sol-gel derived 88 atom-

percent uranium (approximately 9 percent $^{235}U$) 12 atom-percent plutonium oxide, and the cladding is 20 percent cold-worked 316 stainless steel. The capsule is being irradiated in the Oak Ridge Research Reactor (ORR) and has exceeded a burnup of 70 MWd/kg. The fuel has been operated at linear power rates of 39 and 44 kW/m, and peak outer cladding temperature of 565° and 630°C respectively. A similar fuel rod in a previous capsule (GB-9) was subjected to 48 kW/m (685°C). 4 references. (auth)

**30202** (CONF-751024-1) SELECTION OF ENGINEERING MATERIALS AND FABRICATION OF LIQUID METAL FAST BREEDER REACTORS. Patriarca, P. (Oak Ridge National Lab., Tenn. (USA)). 1975. 123p. Dep. NTIS $9.25.

From USA welding technology seminar; London, UK (7 Oct 1975).

Information is presented graphically and pictorially concerning the need for nuclear power; basic nuclear concepts including BWR, PWR, HTGR, and LMFBR; the fissioning process; nuclear reactor fuel; fabrication of reactor vessels for LMFBR's; fabrication of intermediate heat exchangers for LMFBR's; piping fabrication for LMFBR's; transition welds; steam generators for LMFBR demonstration plants worldwide; stress corrosion cracking of steam generator materials and weldments; post-test examination of the Alco/BLH sodium-heated steam generator; alternate steam generator designs; and alternate structural materials. (DCC)

**30203** (CONF-751101-8) EFFECTS OF ENTRAINED GAS ON THE ACOUSTIC DETECTION OF SODIUM BOILING IN A SIMULATED LMFBR FUEL BUNDLE. Leavell, W. H.; Sides, W. H. (Oak Ridge National Lab., Tenn. (USA)). 1975. 6p. Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The relationship between acoustic intensity of nucleate boiling and void fraction was studied in a simulated LMFBR fuel bundle. Results indicate that as the void fraction increases the detected intensity of nucleate boiling decreased until it was indistinguishable from background noise. (JWR)

**30204** (ERDA-tr-63) PRINCIPLES OF CONTROLLING DAMAGE TO FUEL ELEMENTS OF FAST POWER REACTORS ACCORDING TO THE ACTIVITY OF SODIUM AND GAS. Efimov, I. A.; Kulakovskii, M. Ya.; Filonov, V. S. 1972. Translation of Printsipy Kontrolya Razrusheniya TVEL Energeticheskikh Reaktorov na Bystrykh Neitronakh Poaktivnosti Natriya i Gaza. 19p. Dep. NTIS $4.00.

The main requirements which have to be met by systems for determining damage to the fuel elements of fast power reactors by delayed neutrons, gas activity, and sodium coolant activity monitoring are discussed. The influence of reactor layout, detector geometry, neutron background and gamma background on the sensitivity of such systems is examined. Theoretical data are presented on the magnitude of the effective signal resulting from damage to fuel elements in the BN-350 and BN-600 reactors and experimental data relating to the use of such systems in determining fuel element damage during operation in the BR-5 reactor. (auth)

**30205** (GA-A-13148) GAS-COOLED FAST BREEDER REACTOR. Quarterly Report for the Period May 1, 1974–July 31, 1974. (General Atomic Co., San Diego, Calif. (USA)). 26 Sep 1974. Contract AT(04-3)-167. 119p. Dep. NTIS $5.45.

Development programs for the steam generator and helium circulator of the primary coolant system and for the PCRV are being prepared. The core development task is to establish criteria for the design of the GCFR fuel, control, and blanket element assemblies. Analytical methods are being developed for predicting fuel-rod response to transient conditions and for treating thermal-hydraulic and structural analyses of fuel assemblies. A program plan for conducting out-of-pile heat-transfer and fluid-flow tests of fuel assemblies was prepared. The development work on the pressure-equalization system included preparations for static adhesion tests and seal leakage tests of mating parts, development of an analytical model for designing monitoring instrumentation, and development of the fuel-rod manifold. In the fuels and materials task, the status of the thermal- and fast-flux irradiation programs and analyses of data from these experiments is given. A scoping study for an in-pile loop test program was completed. Nuclear analysis and reactor physics work included analytical work for a GCFR critical experiment, surveillance of LMFBR critical assembly experiments, and analytical methods development. (auth)

**30206** (GA-A-13458) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report for the Period February 1, 1975–April 30, 1975. (General Atomic Co., San Diego, Calif. (USA)). 17 Jul 1975. Contract AT(04-3)-167. 235p. Dep. NTIS $7.60.

Progress is reported in the areas of core-element development, fuels and materials development, nuclear analysis and reactor physics, fuel pressure equalization system, core assemblies structural-thermal-flow tests, in-pile safety test loop program, reactor engineering, pressure boundary integrity, reactor safety, refueling system development, shielding requirements, and fuel rod engineering. (DG)

**30207** (GA-A-13558) SHIELDING ANALYSIS OF THE 300-MW(e) GCFR. Cerbone, R. J.; Nagel, M.; Rouse, C.; Razani, A. (General Atomic Co., San Diego, Calif. (USA)). 12 Aug 1975. Contract AT(04-3)-167. 58p. Dep. NTIS $5.45.

Information is presented concerning shielding analysis methods; shielding calculations for the radial shield; and neutron induced activation of the lower shield plug, circulators, and steam generators. 17 references. (DCC)

**30208** (GEAP-13771-14) CRITICAL EXPERIMENTS AND ANALYSIS. Fourteenth Quarterly Report, January–March 1975. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). May 1975. Contract AT(04-3)-893. vp. AT.

Current activities and technical progress for the period January through March 1975 are reported for two subtasks. Subtask A covers the technical direction for critical experiments and analysis as applicable to LMFBR commercial plants and the Clinch River Breeder Reactor Plant Benchmark Critical Experiments in ZPPR Assembly 4 and the CRBRP EMC. Subtask B is directed toward the development of LMFBR plant calculational methods that also can be used at the sites of the Clinch River Breeder Reactor to determine the reactor power distribution, reactivity and fuel status, and for consideration of alternative fuel and control management schemes. (auth)

**30209** (GEAP-13825-12) INSTRUMENTATION DEVELOPMENT. Twelfth Quarterly Report, October–December 1974. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jan 1975. Contract AT(04-3)-893. vp. AT.

The development of instrumentation for surveillance of the core and in-vessel components of liquid metal fast breeder reactors is reviewed. Current development efforts are focused on high temperature neutron detectors and advanced signal transmission methods. This report covers activity during the period October–December 1974. (auth)

**30210** (GEAP-14039-2) ADVANCED OXIDE FUEL SYSTEMS DESIGN AND TRADE-OFF STUDIES. Second Quarterly Report, December 1974, and January–February 1975. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Mar 1975. Contract AT(04-3)-893. 18p. AT.

The 1200 and 2000 MW(e) reference designs were revised. Thermal/hydraulic, mechanical and neutronic calculations are being continued to assure design consistency. Parametric studies were continued in an effort to determine the thermal/hydraulic, mechanical and neutronic performance parameters as functions of plant operating conditions and design variables. This information is being used to form constraint relations to be applied in design trade-off and optimization efforts. Initial programming activities were completed on COROPT, a computer code for performing design trade-off and optimization studies. COROPT is presently undergoing testing prior to the generation of initial trade-off and optimization results. A brief evaluation of trade-off effects associated with low temperature operation was completed. A reactor physics sensitivity study on the 1200 MW(e) reference design was completed. A similar sensitivity study for the 2000 MW(e) design is 75 percent complete. Reactor physics studies were initiated to establish size and technology trade-off effects on core performance. (5 references) (auth)

**30211** (HEDL-SA-767) EFFECT OF SELECTED CORE DESIGN CHANGES ON THE LMFBR DOUBLING TIME. Omberg, R. P.; Rothrock, R. B.; Hardie, R. W. (Westinghouse Hanford Co., Richland, Wash. (USA)). 25 Oct 1974. Contract AT(45-1)-2170. 23p. (CONF-750607-28). Dep. NTIS $4.25.

From American Nuclear Society meeting; New Orleans, Louisiana, USA (8 Jun 1975).

An analysis was made to determine the effect of selected core design changes on the doubling time of a 1000 MW(e) LMFBR with oxide fuel. The basic design change examined was that of increasing fuel pin diameter for different values of the smear density and the linear heat rate. The fuel pin diameter was increased with the pitch-to-diameter ratio held constant in one set of cases, and with the axial pressure loss held constant in the second set. In each of these sets, the fuel pin diameter was increased with a constant clad thickness-to-diameter ratio in one case, and with a constant clad thickness in the second case. (auth)

**30212** (HEDL-SA-917) DAMAGE ANALYSIS: DAMAGE FUNCTION DEVELOPMENT AND APPLICATION. Simons, R. L.; Odette, G. R. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 2 Sep 1975. Contract E(45-1)-2170. 19p. (CONF-750935-6). Dep. NTIS $4.00.

From 1st ASTM-Euratom symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

The derivation and application of damage functions, including recent development for the U.S. LMFBR and CTR programs, is reviewed. A primary application of damage functions is in predicting component life expectancies; i.e., the fluence required in a service spectrum to attain a specified design property change. An important part of the analysis is the estimation of the uncertainty in such fluence limit predictions. The status of standardizing the procedures for the derivation and application of damage functions is discussed. Improvements in several areas of damage function development are needed before standardization can be completed. These include increasing the quantity and quality of the data used in the analysis, determining the limitations of the analysis due to the presence of multiple damage mechanisms, and finally, testing of damage function predictions against data obtained from material surveillance programs in operating thermal and fast reactors. 23 references. (auth)

**30213** (HEDL-SA-954) TEST REACTOR: BASIC TO U. S. BREEDER REACTOR DEVELOPMENT. Miller, B. J.; Harness, A. J. (Westinghouse Hanford Co., Richland, Wash. (USA)). 1975. Contract AT(45-1)-2170. 8p. (CONF-750939-1). Dep. NTIS $4.00.

From 4th international conference of women engineers and scientists; Cracow, Poland (8 Sep 1975).

Long-range energy planning in the U. S. includes development of a national commercial breeder reactor program. U. S. development of the LMFBR is following a conservative sequence of extensive technology development through use of test reactors and demonstration plants prior to construction of commercial plants. Because materials and fuel technology development is considered the first vital step in this sequence, initial U. S. efforts have been directed to the design and construction of a unique test reactor. The Fast Flux Test Facility, FFTF, is a 400 MW(t) reactor with driver fuel locations, open test locations, and closed loops for higher risk experiments. The FFTF will provide a prototypic LMFBR core environment with sufficient instrumentation for detailed core environmental characterization and a testing capability substituted for breeder capability. The unique comprehensive fuel and materials testing capability of the FFTF will be key to achieving long-range objectives of increased power density, improved breeding gain and shorter doubling times. (auth)

**30214** (HEDL-TME-75-2) HEDL QUARTERLY TECHNICAL REPORT, JANUARY, FEBRUARY, MARCH, 1975. Slember, R. J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). May 1975. Contract AT(45-1)-2170. vp. AT.

Information is presented concerning FFTF core physics, radiation and shield analysis, and dynamic response to loss of flow hypothetical core disruptive accident. The effects of core design changes on LMFBR doubling time are analyzed. (DCC)

**30215** (INIS-mf-1386) NUCLEAR ENERGY, SOLUTION OF THE ENERGY CRISIS. Wyart, P. (Organisation des Producteurs d'Energie Nucleaire (O.P.E.N.), 75 - Paris (France)). 6 Jun 1974. 21p. (CONF-7406107-1). INIS.

From 4th annual meeting of the Belgian section of the American Nuclear Society; Mol, Belgium (6 Jun 1974).

The fossil fuel crisis has resulted from an agreement among the producers to organize a price increase. This price increase will cause an accelerated development of nuclear power. Nuclear energy is cheap and the fuel is only a small part of its cost. Safeguards and flexibilities either exist or should be created so that fuel costs cannot be manipulated as in the case of petroleum and cause a sharp non-equilibrium between supply and demand. The future unit cost of isotopic separation remains uncertain and this can affect fuel costs. Agreement among producers of electricity to prevent price fixing by enriched uranium producers should be encouraged. (JSR)

**30216** (KFK-1877) POST IRRADIATION EXAMINATION OF FIFTEEN $UO_2/PuO_2$-FUEL PINS FROM THE EXPERIMENT DRR-350. Geithoff, D. (Kernforschungszentrum Karlsruhe (F. R. Germany)). 28 Aug 1975. 167p. (In German). Dep. NTIS (US Sales Only) $11.50.

Within the framework of the fuel pin development for a sodium cooled fast reactor a subassembly containing 77 fuel pins has been irradiated up to 5.65% fima in the Dounreay fast reactor. The pins were prototypes in terms of fuel and cladding material. The fuel consisted of mechanically mixed $UO_2$ (80%) and $PuO_2$ (20%) pressed into pellets and austenitic steels (W.-No. 1.4961 and 1.4988) were used as cladding material. Furthermore a blanket column of $UO_2$ pellets and a gas plenum were incorporated in the pin. For the irradiation the conditions in a fast breeder were simulated in as much as the linear rod power was fixed at 450 W/cm and a maximum cladding temperature of 630°C was maintained. After the successful completion of the irradiation, the subassembly was dismantled and fifteen pins were selected for a nondestructive and destructive examination. The most important results of the examinations seem to be the migration of fission-product cesium and the fact that no signs of impending pin failure have been found. Thus the pin specification tested in this experiment is capable of achieving higher burnups under the irradiation conditions described above. (auth)

**30217** (KFK-Ext-25/75-1) SURVEY OF THE IMPACT OF INTRODUCING FAST BREEDER REACTORS IN THE DeBeNeLux REGION. Schroeder, R.; Wagner, J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Projekt Schneller Brueter). Jun 1975. 232p. (In German). Dep. NTIS (US Sales Only) $14.25.

A survey of the impact of introducing sodium-cooled fast breeder reactors in the Federal Republic of Germany and the BeNeLux countries (DeBeNeLux region) is presented. The supply situation with respect to electric and thermal energy is studied in particular, together with aspects of economy and environmental impact. The potential and consequences of a breeder economy, the present status and future r + d work are discussed. In addition to sodium-cooled fast breeder reactors with oxide or carbide fuel, alternative solutions are touched: light water and high temperature reactors; helium-cooled fast breeder reactors; and geothermal energy, solar energy and fusion energy. (auth)

**30218** (ORNL-5011) MOLTEN-SALT REACTOR PROGRAM. Semiannual Progress Report for Period Ending August 31, 1974. McNeese, L. E. (Oak Ridge National Lab., Tenn. (USA)). Jun 1975. Contract W-7405-eng-26. 135p. Dep. NTIS $7.60.

Separate abstracts are included for each of the 4 parts presented concerning MSBR design, development, and safety; chemistry; materials development; and fuel processing for molten-salt reactors. (DCC)

*For abstracts of individual sections see: 27570, 27571, 27697, and 30219.*

**30219** (ORNL-5011, pp 1-19) MSBR DESIGN, DEVELOPMENT, AND SAFETY. Engel, J. R. Jun 1975.

In molten-salt reactor program. Semiannual progress report for period ending August 31, 1974. (Oak Ridge National Lab., Tenn. (USA)).

Information is presented concerning the development and performance testing of MSBR systems and components. Failure modes and safety aspects of MSBRs are analyzed. (DCC)

**30220** (ORNL-5047) MOLTEN-SALT REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING FEBRUARY 28, 1975. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 190p. Dep. NTIS $7.60.

Separate abstracts were prepared for sections on design and development, chemistry, materials development, and fuel reprocessing. (JWR)

*For abstracts of individual sections see: 27572, 27698, 28489, and 30221.*

**30221** (ORNL-5047, pp 1-35) MSBR DESIGN, DEVELOPMENT, AND SAFETY. Engel, J. R. Sep 1975.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1975. (Oak Ridge National Lab., Tenn. (USA)).

Progress in the MSBR design and development program is reported in the following areas: design and systems analysis; systems and components development; and safety studies. (JWR)

**30222** (RCN-228) FAST REACTOR PROGRAMME. First Quarter 1975 Progress Report. Hoekstra, E. K. (comp.). (Stichting Reactor Centrum Nederland, Petten). Jul 1975. 51p. Dep. NTIS (US Sales Only) $5.75.

Results of calculations of the capture cross sections of the fission product nuclei $^{127}I$ and $^{101,102,104}Ru$ are given. The in-pile canning failure experiments on fuel pins R54-F35 and F39 and the loss-of-cooling experiments on fuel pins R63-L10 and L12 are described. Progress on the thermodynamic measurements on U(C,N) and on the thermodynamic stability study on cesium uranates is reported. A comparison of results of the low-cycle-fatigue tests on specimens of DIN 1.4948 base material and welded material is given. Aerosol experiments in the ENAK, PERVEX and "200" vessels are commented on. Evaluation of results of the hydraulic experiments with the seven-rod bundle mock-up in water and of the thermohydraulic tests performed

on the artificially roughened rods LUCY 113 and 114 in air is discussed. 30 references. (auth)

**30223** (RT/ING-(75)5) EFFECTS DUE TO THERMAL TRANSIENTS ORIGINATED BY PLANT INCIDENTS AND SOME OPERATING PROCEDURES. Bandiera, P. G.; Cesari, F.; Galvagni, R.; Misley, P.; Righini, R.; Santandrea, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Mar 1975. 66p. Dep. NTIS (US Sales Only) $6.50.

The thermal transients caused by temperature variations and Na flow-rate modifications are taken into account owing their classification, effects on materials and remedies to be assumed during design and operation. Some plant solutions and the main modifications carried out are described for the mixing of streams of different temperatures to achieve the better distribution of the flow-rate, to reduce the cover gas entrainment and finally to limit thermal gradient values. The operating procedures such as post shutdown operational sequence and hot start-up, which allow keeping a tolerable stressing state in the materials, have also been taken into consideration. 12 references. (auth)

**30224** (TID-3334-S2) SODIUM TECHNOLOGY, JULY 1973-DECEMBER 1974. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Aug 1975. 125p. Dep. NTIS $5.45.

References to 811 publications on sodium and NaK technology cited in Nuclear Science Abstracts Volume 28 through Volume 30 are contained in this bibliography. The references were retrieved from the NSA data base using the computerized RECON search system and were formatted for publication with indexes by computer. References are arranged in order by the original NSA abstract number which approximately places them in chronological order. Sequence numbers appear beside each reference, and the indexes refer to these sequence numbers. (auth)

**30225** (WARD-5594) CRBR NUCLEAR, THERMOFLUID, AND ADVANCED FUEL CONCEPTUAL DESIGN. Dickson, P. W. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Advanced Reactors Div.). 1975. 19p. (CONF-750478-2). Dep. NTIS $4.00.

From proceedings of the Breeder Reactor Corporation; Los Angeles, California, USA (15 Apr 1975).

The improvements effected in flow orificing and fuel conceptual design to achieve both the breeding ratio and fuel lifetime goals within the restrictions imposed upon the core and blanket are discussed. The effect of cladding temperature on fuel lifetime is illustrated for either inelastic strain limits or life fraction damage function limits. The temperature varies through life differently for different assemblies. The maximum cladding midwall temperature for the assembly illustrated is just over 1300$^0$F at the beginning of life, also calculated on a conservative basis. This results in a lifetime of 80 MWD/Kg. An initial temperature of closer to 1230$^0$F would be required to achieve a burnup capability of 150 MWD/Kg. It is thus apparent that either the temperatures of the cladding must be decreased, or improved cladding material is required in order to achieve 150 MWD/Kg. (auth)

**30226** ADVANCES AND PROBLEMS OF FAST BREEDER DEVELOPMENT. 1975 Status Report of the Fast Breeder Project on 6.3.75 at Bensberg. Heusener, G. (Kernforschungszentrum Karlsruhe (F. R. Germany). Projekt Schneller Brueter). Atomwirtsch., Atomtech.; 20: No. 5, 261-262(May 1975). (In German).

The focus of the Debenelux program is still on the construction of the SNR-300. Further major projects are KNK-II and SNR-2 as well as the long-term program for the development of carbide fuel. The start-up of KNK-II is now envisaged for summer 1976; KNK-II will then be the main instrument for the integral testing of fast breeder fuel elements. Construction of the SNR-2 is to begin in 1980. Some major projects are connected with the safety of sodium-cooled breeder reactors, among them development programs for the investigation of core behaviour during excursion incidents. Large-scale sodium test facilities were already in full operation in the year under review. (GE)

**30227** FISSION PRODUCT REACTIONS AND THERMOMIGRATION IN BREEDER REACTOR OXIDE FUEL SYSTEMS: CESIUM/TELLURIUM-INDUCED CLADDING ATTACK AND CESIUM/FUEL CHEMICAL INTERACTION. Aitken, E. A.; Adamson, M. G.; Dutina, D.; Evans, S. K. (General Electric Co., Sunnyvale, CA). pp 187-205 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

The results of isothermal capsule tests containing mixtures of cesium and tellurium with various oxygen buffers and heated to between 450 and 1000°C for periods of 100 and 1000 hours show that intergranular attack of Type-316 stainless steel occurs when Cs/Te less than or equal to 2 and the oxygen potential of the buffer exceeds the oxidation threshold for stainless steel. Carbon increases the tendency for intergranular penetration if the oxygen potential is slightly above the oxidation threshold (DELTA anti G/sub $O_2$//sup 725$^0$C/ equals -134 kcal/mol). At high oxygen potentials (DELTA anti G/sub $O_2$//sup 725$^0$C/ approximately equal to -100 kcal/mol), carbon has no effect on enhancing the attack. Activation energies for carbon assisted and non-carbon assisted attack were found to be 21.5 and 17.5 kcal/mol, respectively. To cause attack by cesium alone, or cesium with molybdenum oxide, an oxygen potential greater than -84 kcal/mol was necessary. Reaction experiments show that the compound $Cs_{1+3}(U, Pu)O_3$ is more stable than $Cs_2UO_4$ and $Cs_2MoO_4$. $Cs_2MoO_4$, however, may be stable in irradiated fuel pins because of its ability to volatilize and deposit on the inside of the cladding surface. (auth)

**30228** ROLE OF CsI IN THE DEVELOPMENT OF REACTIONS AT THE INTERFACES BETWEEN $(U,Pu)O_2$ FUELS AND AUSTENITIC STAINLESS STEEL CLADDING. Calais, D.; Aubert, M.; Le Beuze, R.; Conte, M.; Mikailoff, H. (CEN, Fontenay-aux-Roses, France). pp 207-216 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975). (In French).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

Out-of-pile simulation experiments were performed in order to study the isotherm and temperature-gradient compatibility of the following systems: steel/$I_2$, steel/Cs, steel/Cs + $Cs_2O$, steel/Cs + CsOH, steel/CsI, steel/$(U,Pu)O_{2\pm X}$, steel/$I_2$ + $(U,Pu)O_{2\pm X}$, steel/Cs + $(U,Pu)O_{2\pm X}$, steel/CsI + $(U,Pu)O_{2\pm X}$. Metallography, x-ray diffraction and x-ray microanalysis techniques were used in order to gain a better understanding of the development of reactions at the fuel-cladding interfaces in reactors. These experiments revealed a gaseous phase transfer phenomenon of the Van Arkel type involving stainless steel (low temperature) and the oxide $(U,Pu)O_{2\pm X}$ (high temperature) through the agency of cesium iodide. This transfer phenomenon, which is basically concerned with the displacement of manganese, chromium, and iron from cold zones to hot zones, is possible only where there is an oxygen source (the mixed oxide $(U,Pu)O_{2\pm X}$ in particular). CsI reacts with stainless steel where the mixed oxide $(U,Pu)O_{2\pm X}$ is present and forms manganese, chromium and iron iodides and cesium uranoplutonate $Cs_2(U,Pu)O_4$. The iodides $MnI_2$, $CrI_2$ and $FeI_2$ decompose in the hot zones, giving rise to precipitation of manganese, chromium and iron and releasing the iodine, which is thus available for further reactions with the steel, in the form of cesium iodide. This is reflected in a gradual dechromization of the steel, the resistance of which to oxidation then decreases and it may thus react directly with the mixed oxide $(U,Pu)O_{2\pm X}$. In the thin sections taken from the fuel elements of fast reactors of the Rapsodie type (steel-316 cladding, $(U,Pu)O_2$ oxide fuel) after irradiation, magnetic precipitates rich in iron and chromium in the fuel as well as dechromization of the cladding material can be observed. (auth)

**30229** OXYGEN EQUILIBRIUM IN OXIDE FUEL/Na COOLANT CHEMICAL INTERACTIONS. Adamson, M. G. (General Electric Co., Pleasanton, CA); Aitken, E. A. pp 233-250 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria(21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

Results of recent determinations of the equilibrium oxygen concentration C/sub O/sub Na//sup eq/ and the equilibrium oxygen potential DELTA anti G/sub $O_2$//sup eq/ in sodium/oxide fuel reaction mixtures are reported. Measurements were performed using the vanadium wire equilibration technique and high-temperature solid electrolyte emf cells. Available thermodynamic property data for reactants and products in the sodium-fuel reaction are reviewed. The results of theoretical calculations of DELTA anti G/sub $O_2$//sup eq/ and C/sub O/sub Na//sup eq/ are compared with the experimental results and critically evaluated. The serious discrepancy between the "low" vanadium-wire C/sub O/sub Na//sup eq/ results and the higher emf cell/thermochemically-calculated results is attributed to shortcomings in the existing vanadium-wire equilibration method. Discrepancies between DELTA anti G/sub $O_2$//sup eq/ values derived from measured mixed oxide fuel O:M thresholds and the emf cell/thermochemically-calculated results are tentatively ascribed to errors in Markin and McIver's low-temperature oxygen potential data for hypostoichiometric mixed oxide. Deficiencies in the high-temperature thermodynamic data for dilute solutions of oxygen

in sodium are also identified. Present best estimates of C/sub O/ sub Na//sup eq/ are 1.0 +- 0.4 ppM at approximately 625°C and 1.5 ppM at 750°C. At this level, failed LMFBR-type mixed-oxide fuel pins may continue their irradiation inside normal coolant loops without undergoing severe additional swelling due to reaction with oxygen in the coolant. (auth)

**30230** DISPUTE ON A NEW TECHNOLOGY. Fast Breeder: Are There Millions Dissipated. Bild Wiss.; 11: No. 12, 100-113(Dec 1974). (In German).

Energy experts, economists, and producers discuss the need for the fast breeder or whether the cost of its development is comparable with the expected success. It is difficult to keep the estimated cost exactly and the economy is in question. The politicians are very skeptical, but the scientists have absolute confidence in success. (GE)

**30231** UNDER WHAT CONDITIONS DOES A REACTOR BREED. Keller, C. Bild Wiss.; 11: No. 12, 100-101(Dec 1974). (In German).

1 fig.

After a summing-up of the nuclear processes occurring in thermal reactors, the conditions for breeding are illustrated. Fast breeders are able to utilize the energy content of uranium about one hundred times better than thermal reactors. Furthermore, thorium can be utilized which is found about five times more abundant than uranium. The ideal fuel for a breeder is plutonium produced in thermal reactors. (GE)

**30232** FAST BREEDER REACTORS FOR THE LONG-TERM ENERGY SUPPLY. Hueper, R. (Kernforschungszentrum Karlsruhe (F. R. Germany). Projekt Schneller Brueter). Umsch. Wiss. Tech.; 75: No. 5, 153-159(Mar 1975). (In German).

3 refs.

The international state of development as well as international efforts in FBR technology are discussed. (GE)

## Research, Test, and Experimental Reactors

*Refer also to abstracts 27993, 30134, 30214, 30285, 30340, 30434, and 30441.*

**30233** (AAEC/E-337) MEASUREMENT AND REDUCTION OF FLOW-INDUCED VIBRATION OF A FUEL ELEMENT AND RIG IN THE HIFAR REACTOR. Harris, R. W.; Holland, P. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1975. 24p. Dep. NTIS (US Sales Only) $4.25.

Flow-induced vibrations in the fuel element assembly of a research reactor were monitored and it was established that long-term monitoring of liner plug vibration can be used to indicate the mechanical integrity of a fuel element if a sufficient case history is established. The vibrational behavior of a number of fuel elements with different integral modifications was examined but only a relatively small change in vibration levels was obtained. The overall vibration levels were most effectively decreased by installing flow straighteners in the exit nozzles of the plenum chamber. (auth)

**30234** (AIAU-740307) OPERATION EXPERIENCE WITH THE TRIGA MARK II REACTOR VIENNA IN THE YEARS 1972 THROUGH '74. Boeck, H. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Oct 1974. 15p. (CONF-7410123-1).

From 3rd European conference of TRIGA users; Neuherberg, F. R. Germany (29 Oct 1974).

An operations experience with the TRIGA Mark II reactor Vienna is given covering the period from 1972 to 1974. Work has been performed especially on the cooling circuit. Some failures with the control rods and with the fuel element thermocouples have been observed. (auth)

**30235** (AI-ERDA-13147) SODIUM TECHNOLOGY AND COVER GAS SEAL DEVELOPMENT PROGRAMS. Quarterly Technical Progress Report, January-March 1975. (Atomics International Div., Canoga Park, Calif. (USA)). 15 May 1975. Contract AT(04-3)-824. 123p. AT.

Progress made in the development and testing of techniques and procedures for the sodium removal and decontamination of LMFBR coolant loop components is reported. Friction test data on FFTF materials are presented. The testing of cover gas seals for LMFBR and FFTF cooling systems is described. (DCC)

**30236** (DP-Report-810) INFLUENCE OF CONTROL ROD PATTERNS ON THE 3-DIMENSIONAL POWER DISTRIBUTION IN THE DRAGON REACTOR. Dragon Project. Hunt, C.; James, R. M. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Sep. 1972. 34p. Dep. NTIS (US Sales Only) $4.75.

A series of 3-dimensional reactor calculations made for a simplified representation of the Dragon Reactor are reported. The prime aim of the work is to recommend the best mode of operation of the control rods in the future. The results also illustrate the complicated variations in both the axial form factors and the total channel powers due to the different control rod patterns which have been used in the past. (auth)

**30237** (EURFNR-1234) HIGH PRESSURE CAPSULE FOR IRRADIATING FUEL EXPANSION SAMPLES IN THE FR2. Haefner, H. E. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Oct 1974. Translation of KFK-2068. 38p. Dep. NTIS $4.00.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The design, development, and testing of a high-pressure irradiation capsule for the FR-2 reactor is described. The capsule is intended for the study of expansion in fuel materials. (JWR)

**30238** (HEDL-TME-75-42) INSPECTION OF CORE RESTRAINT PLUG IN CRCTA. Danker, W. J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-2170. 27p. AT.

The core restraint plug in Port No. 26 of the Composite Reactor Component Test Activity (CRCTA) cover was withdrawn, inspected, and reinserted on March 27, 1975. It is intended to periodically inspect this plug to monitor and evaluate sodium deposition rates versus the CRCTA operating history. Since the CRCTA system provides a prototypic sodium, thermal environment for testing FFTF prototype equipment and components, these inspection results should be of interest to a variety of disciplines including component design, operations, and maintenance engineering. This report documents the equipment and procedures employed and the results obtained. (auth)

**30239** (HEDL-TME-75-78) METHODS FOR MONITORING THE INITIAL LOAD TO CRITICAL IN THE FAST TEST REACTOR. Johnson, D. L. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-2170. 23p. Dep. NTIS $4.00.

Conventional symmetric fuel loadings for the initial loading to critical of the Fast Test Reactor (FTR) are predicted to be more time consuming than asymmetric or trisector loadings. Potentially significant time savings can be realized by the latter, since adequate intermediate assessments of neutron multiplication can be made periodically without control rod reconnection in all trisectors. Experimental simulation of both loading schemes was carried out in the Reverse Approach to Critical (RAC) experiments in the Fast Test Reactor-Engineering Mockup Critical facility. Analyses of these experiments indicated that conventional source multiplication methods can be applied for monitoring either a symmetric or asymmetric fuel loading scheme equally well provided that detection efficiency corrections are employed. Methods for refining predictions of reactivity and count rates for the stages in a load to critical were also investigated. (auth)

**30240** (INIS-mf-1703, pp 247-268) NUCLEAR START-UP AND INITIAL OPERATION AT POWER OF UNIT 1 OF THE BILIBINSK ATOMIC POWER STATION. Minashin, M. E.; Vajmugin, A. A.; Abalakin, V. K. 1974. (In Russian).

From jubilee conference dedicated to the twentieth anniversary of nuclear power engineering; Obninsk, USSR (25 Jun 1974).

In nuclear power plant operating experience and prospects of nuclear power engineering. Vol. 2. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow).

The results of the investigation of the physical characteristics and biological shielding of the unit I reactor of the Bilibinsk nuclear power plant during start-up and initial operation were described. The results of start-up control, reactor operation at 30 and 50% power and reactor and loop cooling during type I and II scram at these power levels and during planned shut-down were also reported. The results confirmed the design characteristics of the active zone, the biological shield, and operation under natural circulation of the coolant during start-up, operation at different power levels, and reactor cooling. (tr-auth)

**30241** (IPR-DR-62, pp 1-11) APPLICATION OF THE NEUTRON PULSED SOURCE TECHNIQUE TO THE URANIE SUBCRITICAL ASSEMBLY. Preliminary results. Santoro, C. A.; Resende, M. F. R.; Ferreira, O. C.; Soares, P. A.; Holland, L.; Stasiulevicius, R.; Isasi, J. A. S. Nov 1972. (In Portuguese).

From seminar on reactor physics; Belo Horizonte, Brazil (1972).

In application of the neutron pulsed technique to the URANIE subcritic and analysis of noise of Triga Mark I reactor. (Instituto de Pesquisas Radioativas, Belo Horizonte (Brazil)).

The immediate objective was to obtain parameters of the multiplying medium (asymptotic decay constants and reactivities). The important non-immediate objective, however, was the acquisition of experimental techniques (including a set of programs for numerical calculation) for future exploration of the heavy water subcritical assembly CAPITU. Theory and experimental equipment are described. Experimental results are presented and discussed. Recommendations are given about: monitoring the pulse, analyzing the decay curves, and shielding the experimental arrangement. (INIS)

**30242** (IPR-DR-62, pp 12-37) INTRODUCTION TO NEUTRON NOISE OF A TRIGA REACTOR. Santoro, C. A.; Resende, M. F. R.; Ferreira, O. D.; Soares, P. A.; Holland, L.; Stasiulevicius, R.; Isasi, J. A. S. Nov 1972. (In Portuguese).

From seminar on reactor physics; Belo Horizonte, Brazil (1972).

In application of the neutron pulsed technique to the URANIE subcritic and analysis of noise of Triga Mark 1 reactor. (Instituto de Pesquisas Radioativas, Belo Horizonte (Brazil)).

Correlation techniques, in the time domain, were used with the objective of determining the prompt neutron decay constant for the TRIGA MARK I reactor; and spectral density techniques were used for obtaining its transfer functions. From the self-correlation obtained, it was not possible to obtain any information, because of low detector efficiency. Neither were the results obtained for the transfer function satisfactory; the coherence function obtained had very low values. (INIS)

**30243** (ORNL-5027) REVIEW OF ORNL RADIATION SHIELDING ANALYSES OF THE FAST FLUX TEST FACILITY REACTOR. Abbott, L. S.; Mynatt, F. R. (Oak Ridge National Lab., Tenn. (USA)). Jul 1975. Contract W-7405-eng-26. vp. AT.

The design support analyses performed at Oak Ridge National Laboratory to predict the neutron and secondary-gamma-ray fluxes and dose rates and the sodium-activation gamma-ray dose rates that can be expected at various locations in the Fast Flux Test Facility (FFTF) are reviewed. The calculations were concentrated in areas of particular concern to the facility designers. The regions studied were: the stainless steel shield below the reactor core; the steel and sodium region above the core; the clearance gaps around massive plugs that rotate within the thermal shield and pressure vessel head above the sodium pool; the region between the side of the core and the pressure vessel wall, including a stored-fuel region; a large nitrogen-filled cavity surrounding the reactor pressure and guard vessels, in which a concrete shield was introduced; the vessel support system; the branch-arm pipe and center-island shielding in the head compartment; and the regions outside the reactor vessel through which the sodium coolant ducts lead to the primary heat exchangers. (auth)

**30244** (ORNL-TM-175) DESCRIPTION OF MANIPULATOR SYSTEM, HELIARC UNDERWATER CUTTING TORCH, AND PROCEDURE FOR CUTTING THE HRE-2 CORE. Holz, P. P. (Oak Ridge National Lab., Tenn. (USA)). 5 Nov 1962. Contract W-7405-eng-26. 29p. Dep. NTIS $4.50.

A manipulator system incorporating a simplified heliarc underwater cutting torch was designed, developed, tested, and applied to cut remotely the HRE-2 core into slices. Fifty-seven cut specimens averaging 3 in. by 9 in. were transferred to buckets and forwarded to a hot cell for complete metallurgical analysis. (auth)

**30245** (WARD-2171-51) FAST FLUX TEST FACILITY. Quarterly Progress Report for the Period Ending February 28, 1975. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1975. Contract E(11-1)-2171. 50p. AT.

Information is presented concerning reactor engineering; head compartment and shielding design; in-vessel handling machine and instrumentation and control system components; plant fluid systems and mechanical components; nuclear safety; and development testing. (DCC)

**30246** AMERICAN NATIONAL STANDARD OPERATION OF FAST PULSE REACTORS. National Standard N394-1975 (ANS-14.1). Hinsdale, IL; American Nuclear Society (1975). 7p. $7.50.

Nuclear devices designed and operated for purposes of research and as sources of sharp, intense pulses of fission-produced radiation are called fast pulse reactors. In the usual operation, super-prompt criticality is established in a mass of unmoderated fissile metal, radiation is produced, and the nuclear reaction is immediately terminated by characteristics inherent in the fissile material itself. This standard provides direction in the use of such specialties so that the risk of damage to personnel and equipment can be minimized. (auth)

**30247** DIRECT MEASUREMENT OF REACTIVITY FOR CONTROL ROD CALIBRATION. Emslie, W. A.; Park, G. L.; Wilkinson, B. W. (Michigan State Univ., East Lansing). pp 431-434 of Advances in Test Measurement. Vol. 11. Washburn, B. (ed.). Pittsburgh; Instrument Society of America (1974).

From 20th international instrumentation symposium; Albuquerque, New Mexico (21 May 1974).

A simple inexpensive instrument for measuring the reactivity of a low-power nuclear reactor is described. The readout is directly in cents on a standard meter movement and the instrument is compactly designed using readily-available electronic modules. It is in regular use on the Michigan State University TRIGA reactor. (auth)

**30248** AN IN-PILE PRESSURIZED FISSION-PRODUCT SWEEP RIG. Rosen, R. (New South Wales Univ., Kensington (Australia)). Nucl. Eng. Des.; 32: No. 3, 394-401(1975).

A pressurized in-pile sweep rig which produces a continuous supply of the short-lived fission-product krypton and xenon gases is described. The rig, located in the Australian Atomic Energy Commission reactor HIFAR, contains a natural uranium specimen and operates at pressures up to 14.6 atm. The safety features considered in the design include temperature, pressure and leakage. The methods used to calculate the expected rate of heat generation and the resultant temperatures of the various components are outlined. An estimate is made of the expected gas activity. Problems encountered in the design are discussed. The results of four years' operating experience are reviewed. (auth)

## Production and Materials Testing and Processing Reactors

*Refer also to abstracts 30195, 30233, and 30339.*

**30249** (DUN-7844) BENCH TEST RECOVERY OF RTD CABLE RESISTANCE AFTER IMMERSION IN TURCO 4521. Lander, W. E. B. (Douglas United Nuclear, Inc., Richland, Wash. (USA)). 11 Jan 1972. 2p. Dep. NTIS $4.00.

All three RTD cable pieces exhibited a resistance value of less than one megohm immediately following the immersion of the RTD cable samples in the Turco 4521 solution. All three recovered to near original values within six hours of drying in normal office conditions. Based on this test and others, there does not appear to be any significant problem associated with the Turco 4521 getting on the RTD splices in the N-Reactor. (auth)

**30250** (DUN-SA-195) MINICOMPUTER CONTROLLED TEST SYSTEM FOR PROCESS CONTROL AND MONITORING SYSTEMS. Worster, L. D. (Douglas United Nuclear, Inc., Richland, Wash. (USA)). [nd]. 11p. Dep. NTIS $4.00.

A minicomputer controlled test system for testing process control and monitoring systems is described. This system, in service for over one year, has demonstrated that computerized control of such testing has a real potential for expanding the scope of the testing, improving accuracy of testing, and significantly reducing the time required to do the testing. The test system is built around a 16-bit minicomputer with 12K of memory. The system programming language is BASIC with the addition of assembly level routines for communication with the peripheral devices. The peripheral devices include a 100 channel scanner, analog-to-digital converter, visual display, and strip printer. (auth)

## Propulsion and Package Reactors

*Refer also to abstracts 30314 and 30442.*

**30251** (AGC-278N-C) TEST DATA REPORT FOR STRUCTURAL TEST OF THE NERWI STRUCTURAL ASSEMBLY. Brown, S. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). 22 Apr 1963. Contract SNP-1. 107p. Dep. NTIS $8.50.

Declassified 10 Oct 1975.

Instrumented hydrostatic pressure tests were performed on the NERWI Structural Assembly, consisting of the KIWI-B 6061 No. 5 Pressure Vessel, and the Hybrid (NERWI) Nozzle. Objectives were to substantiate the structural integrity of the assembly at ambient temperature, verify the design analysis and provide strain and deflection data for use in further analyses. A premature failure occurred in the nozzle bolt flange shear lip, at 94.9% of nozzle proof pressure. Failure analyses revealed that this failure was primarily due to inadequate strength of the cast aluminum nozzle material. This test was considered par-

tially successful, however, in that: structural integrity of the assembly was substantiated except for the understrength interface; and considerable experimental strain and deflection data were obtained for comparison with analytical data. (auth)

**30252** (AGC-0716(02)MP) NERVA ENGINE EXPLOSIVE DESTRUCT SYSTEM, SUBTASK 1.6. Monthly Progress Report for November 1962. (Aerojet-General Corp., Downey, Calif. (USA)). 1962. Contract SNP-1. 103p. Dep. NTIS $8.25.
Declassified 18 Sep 1975.
The objective of the program is to satisfy two basic NERVA safety requirements: (1) rendering the NERVA reactor essentially harmless in the event of accident or malfunction prior to its use, and (2) disposing of the fission products generated during operation of the reactor prior to the engine's reentry into the earth's atmosphere. The means for meeting the first requirement is termed "anticriticality" and concerns fracturing the reactor core into subcritical masses. The anticriticality mode extends from launch pad handling to NERVA engine start-up. The means for meeting the second requirement is termed "postoperation" and concerns pulverizing the core into particles less than 1/32 in. in diameter which will burn up during reentry. The postoperation mode extends from NERVA engine start-up to engine destruction. To meet both anticriticality and postoperation safety criteria, explosive destruct systems are being investigated. Current results are presented for basic fragmentation research, the explosive irradiation program, mechanical feasibility study of the various proposed systems, the anticriticality destruct system, and the postoperation destruct system. (auth)

**30253** (AGC-0717-16(01)MP) NERVA ENGINE EXPLOSIVE DESTRUCT SYSTEM, SUBTASK 1.6. Monthly Progress Report for October 1963. (Aerojet-General Corp., Downey, Calif. (USA)). 1963. Contract SNP-1. 20p. Dep. NTIS $4.00.
Declassified 24 Sep 1975.
The objective of this program during CY 1964 is to design, fabricate, test, and evaluate a postoperational safety subsystem, having bifunctional capability, that is capable of being integrated into the NERVA engine complex. During the anticriticality phase of operation, this explosive destruct system must be capable of dividing the reactor core into subcritical fragments and of dispersing these fragments into a pattern such that a critical nuclear mass relationship cannot form when immersed in a moderating environment such as water. These tentative criteria, in terms of practical test techniques, established that a maximum concentration of 12.5 lb of fueled core material or simulant can be allowed to fall within any surface area represented by a circle 25 in. in dia. During the postoperational phase, this explosive destruct system must be capable of ensuring that no dangerous accumulation of radioactive particles generated during engine operation falls on populated areas of the earth's surface. This tentative objective establishes that the entire mass of fueled elements comprising the NERVA core must be fragmented into sizes less than 1/32 in. (auth)

**30254** (AGC-746-10) DYNAMIC ANALYSIS OF THE KIWI-B-4A REACTOR CORE STRUCTURE. (Aerojet-General Corp., Azusa, Calif. (USA)). Jul 1963. 52p. Dep. NTIS $5.75.
Declassified 23 Sep 1975.
A study is made concerning the dynamic behavior of the Kiwi B4 reactor core elements. Free vibrations, and the effects of forcing functions arising from fluctuating pressure systems within the core complex, are investigated. The effects on dynamic response, as a result of mass flow rates and gas velocity through the element, coupled with a variation in boundary restraints, are defined. The effects on the natural frequency imposed by a variation of axial load and boundary restraints, are determined singularly and in combination. Transient and steady-state environmental conditions are investigated, and a failure analysis is conducted on the fuel-element cluster assembly. (auth)

**30255** (AGC-746-17) ANALYSIS OF NERVA NOZZLE BOND STRESSES. Richie, C. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1964. 64p. Dep. NTIS $6.25.
Declassified 22 Sep 1975.
An analytical program was carried out to determine the strength of bond required to maintain a structural connection between the NERVA nozzle coolant tubes and jacket. Operating conditions considered are: (1) the transient "NRX-A $LH_2$ Cold Flow" condition, (2) the steady state "full power" condition, and (3) hydrostatic proof test. Results of a detailed stress analysis indicate that the most severe thermal gradients and corresponding thermal stresses occur at an elapsed time of 5.0 seconds during the transient "NRX-A $LH_2$ Cold Flow" condition. Values of normal and shear stresses are recommended as a minimum requirement for allowable bond strength. (auth)

**30256** (AGC-808N-R) HYDROSTATIC PROOF TEST OF THE NRX-A ALUMINUM PRESSURE VESSEL. Smith, L. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1 Aug 1963. Contract SNP-1. 107p. Dep. NTIS $8.50.
Declassified 23 Sep 1975.
NRX-A Pressure Vessel S/N 0000002 was instrumented with strain gages and deflection transducers, and subjected to 100 per cent proof pressure at laboratory ambient temperature. The vessel successfully sustained the pressure, proving the structural integrity of the design. The nozzle simulator, S/N 001S, utilized in this test also successfully withstood the programmed pressure. Predicted strains and deflections for the nozzle and pressure vessel were verified by the test data. (auth)

**30257** (AGC-2518) DYNAMIC ANALYSIS KIWI-B4A REACTOR CORE CLUSTER. Fernandez, D.; Clark, R. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 12 Mar 1963. 48p. Dep. NTIS $5.50.
Declassified 18 Sep 1975.
A study is made concerning the dynamic behavior of the Kiwi B4 reactor core elements. Free vibrations, and the effects of forcing functions arising from fluctuating pressure systems within the core complex, are investigated. The effects on dynamic response, as a result of mass flow rates and gas velocity through the element, coupled with a variation in boundary restraints, are defined. The effects on the natural frequency imposed by a variation of axial load and boundary restraints, are determined singularly and in combination. Transient and steady-state environmental conditions are investigated, and a failure analysis is conducted on the fuel-element cluster assembly. (auth)

**30258** (AGC-8209-64-3) THERMAL ANALYSIS OF ALUMINUM JACKETED NOZZLE UNDER NRX-A2 AND NRX-A5 TRANSIENT CONDITIONS. Thomas, E. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). 27 Feb 1964. 73p. Dep. NTIS $5.50.
Declassified 24 Sep 1975.
Transient thermal analyses were performed on the cast aluminum jacket of the NRX-A nozzle (P/N 284800) for NRX-A2 and NRX-A5 nuclear startup transient conditions as well as nuclear steady state conditions. The NRX-A2 analysis consisted of three parts; first a ramped startup consisting of a series of power and flow ramps separated by steady state plateaus finally reaching 25% reactor power, second a reduced power hold, and third another series of ramps and plateaus until 100% reactor power was reached. Thermal plots were made at the time points which coincided with the upper limit of each ramp where the thermal gradient was assumed to be the most severe. A steady state analysis was performed for the steady state reduced power hold portion to provide initial values for the second startup cycle. The NRX-A5 startup transient was assumed to be the engine startup transient defined in the engine model specification. For all transient analyses, a conductance of 500 BTU/hr $ft^2$°R was assumed for the bond between nozzle tubes and jacket. For the steady state cases, a conductance of 100 BTU/hr $ft^2$°R was used. The section analyzed was a one inch slab cut axially through the jacket. In all cases the temperature gradients are mild. The power and flow ramps which the nozzle will be exposed to are gentle, therefore there is no thermal shock problem. (auth)

**30259** (AGC-10097B) PRELIMINARY MODEL SPECIFICATION: ENGINE, ROCKET, NUCLEAR, SHIELDED HEATED-BLEED. (Aerojet-General Corp., Sacramento, Calif. (USA)). 10 Feb 1962. 48p. Dep. NTIS $5.50.
Declassified 23 Sep 1975.
This specification establishes the requirements for the AJ31-6 Shielded Nuclear Rocket Engine (FX Series) with heated-bleed turbopump drive gas, which is a liquid propellant, turbopump-fed, nuclear engine designed to operate at a nominal vacuum thrust level of 55,800 pounds. The engine consists of the following systems: propellant feed system with a turbopump assembly, connecting lines and fittings for propellant flow; a reactor assembly consisting of graphite core, beryllium reflector, and primary shield; a thrust chamber assembly consisting of a pressure vessel enclosing the reactor assembly, a nozzle assembly, gimbal mechanism, and roll control assemblies all supported by a thrust structure; tank pressurization supply system for pressurizing the vehicle propellant tank; control systems for engine and attitude controls; a diagnostic instrumentation system (flight type); pneumatic supply system; and destruct systems. The propellant is liquid hydrogen furnished from the vehicle tank through a tank shutoff valve on the engine. The turbine will be accelerated during start-up using gas generated from the heat capacity of the nozzle, reflector, and shield. Tank pressure causes the initial flow of propellant through the engine and this pressure is supplemented by pump pressure rise as the turbopump accelerates. The engine is capable of restart. (auth)

**30260** (GESR-2117) DEVELOPMENT OF A SPACE THERMIONIC REACTOR POWER PLANT. First Periodic Progress Report, July 1, 1968–October 31, 1968. (General Electric Co., Pleasanton, Calif. (USA)). 1968. 223p. Dep. NTIS $14.25.
Declassified 20 Oct 1975.
Progress in the development of a thermionic reactor power plant for space use is reported. (JWR)

**30261** (NTO-0048) NRX-A3 POST TEST REPORT. Supplement II. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 5 Nov 1965. 37p. Dep. NTIS $5.00.
Declassified 29 Sep 1975.
Fuel elements were selected after the NRX-A3 reactor test and fatigue tested at the R-MAD facility hot cells. Some dependence on fuel loading and coating was found. The elements become less rigid (or more flexible) at room temperature after exposure to high temperatures and nuclear fissions. Instrumentation lead fractures adjacent to the braze fillets on the braze plugs were examined metallurgically. Additional radiation decay measurements were accumulated for decay rate studies. (LTN)

**30262** (RN-63005A(Vol. 1)) REVISED PROGRAM PLAN FOR CONTRACT YEAR 1964. NERVA ENGINE DEVELOPMENT PROGRAM AND ASSOCIATED TASKS. Volume I. Summaries and Work Statements. (Aerojet-General Corp., Azusa, Calif. (USA)). Dec 1963. 232p. Dep. NTIS $9.00.
Declassified 24 Sep 1975.
Aerojet-General Corporation's revised definition of the work to be performed during Contract Year 1964 in the development of the NERVA nuclear rocket engine under Contract SNP-1 is presented and the estimated costs of this effort are established. This program plan conforms with Aerojet-General's interpretation of the SNPO-C guidelines established subsequent to September 1963. The program plan is presented in seven volumes. Volume I is a program summary and contains the suggested work statements, cost summaries and overall program discussion. (auth)

**30263** (RN-A-0003(Vol.2)) NERVA SUMMARY REPORT FOR CONTRACT YEAR 1964. Volume II. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1964. 178p. Dep. NTIS $12.00.
Declassified 29 Sep 1975.
NERVA work during the Contract Year 1964 is summarized under 32 headings, mainly with respect to test facilities and test facility operations. (LTN)

**30264** (RN-DR-0048) ADVANCED ENGINE ANALYSIS PRESENTATION. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1964. Contract SNP-1. 14p. Dep. NTIS $4.00.
Declassified 30 Sep 1975.
Material presented at an advanced engine analysis presentation has been documented. An advanced NERVA II design study of an engine of 230,000 lbs nominal thrust and incorporating a counter flow tie tube system and including an investigation of the full operating range performance was presented. The possibility of operating these engines in a three unit cluster was investigated, especially with respect to propellant heating rates, shield weight, reactor coupling (especially effects on start-up), control requirements, performance, etc. (LTN)

**30265** (RN-DR-0054) ADVANCED ENGINE ANALYSIS PRESENTATION, 19 FEBRUARY 1965, LOS ALAMOS SCIENTIFIC LABORATORY. (Aerojet-General Corp., Sacramento, Calif. (USA)). 19 Feb 1965. 104p. Dep. NTIS $8.25.
Declassified 30 Sep 1975.
All presentation aid material, together with explanatory text, used during an oral briefing on the Advanced Engine Analysis given at the Los Alamos Scientific Laboratory, on 19 February 1965 has been documented. The briefing and this document present the results of a study to define an advanced nuclear rocket propulsion system in terms of conceptual design and operational characteristics. Also included are study objectives, approach, and status of the Advanced Engine Analysis being conducted during Contract Year 1965 under the SNP-1 Contract, and the results of a REON-initiated study to define facility requirements for testing of clustering nuclear engines. (auth)

**30266** (RN-DR-0079(Vol.5)(Bk.2)) NERVA ENGINE DEVELOPMENT PROGRAM PLAN. Volume V, Book 2. Component Design and Acceptance Criteria. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1966. 351p. Dep. NTIS $20.75.
Declassified 18 Sep 1975.
Design criteria and acceptance specifications are provided for numerous NERVA reactor components, especially valves, actuators, turbopumps, nozzles, pressure vessels, etc. (LTN)

**30267** (RN-DR-0080(Vol.1)) NERVA PROGRAM STATUS REVIEW, SACRAMENTO, MAY 3–5, 1966. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1966. 348p. Dep. NTIS $20.50.
Declassified 29 Sep 1975.
Material presented at the NERVA Program Status Review consists of detailed test results, post-test examination, etc., of the NRX-A4-EST reactor. The NRX/EST major system accomplishment was the demonstration of the bootstrap capability of the NERVA engine system. In addition, performance was demonstrated at or near design conditions of: (1) power level greater than 1000 megawatts for 29.5 minutes, (2) turbopump rotational speed greater than 18,000 rpm for 41.0 minutes and (3) total operating time for 116.3 minutes with turbopump speed indicated. (auth)

**30268** (RN-DR-0080(Vol.3)) NERVA PROGRAM STATUS REVIEW, SACRAMENTO, 3–5 MAY 1966. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1966. 226p. Dep. NTIS $14.50.
Declassified 29 Sep 1975.
Components discussed include actuators, nozzles, thrust structures, pressure vessels, turbopumps, propellant feed systems, etc. Reactor materials developments and new processing methods are reported. Test facilities and operations are discussed in detail, including control systems, nuclear exhaust equipment, MAD operations, remote handling equipment, etc. (LTN)

**30269** (RN-DR-0170) STRUCTURAL-SUPPORT COOLANT SUBSYSTEM (SSCSS), LIMITS AND THE EFFECTS OF CHANGES IN LIMITS. (Aerojet-General Corp., Sacramento, Calif. (USA)). 12 Mar 1969. 19p. Dep. NTIS $4.00.
Declassified 18 Sep 1975.
The following conclusions are drawn from information and analysis based on the current NERVA SSCSS design: the current SSA design is near optimum within the constraints imposed by the nuclear subsystem; the minimum-stem-temperature constraint might be eliminated, but the net effect would be small; increasing SSCSS worth at 100% power by increasing available pressure might be practical, on the assumption that minimum-stem-temperature limit does not exist; increasing SSCSS worth at 60% power and 4500°R chamber temperature by increasing available pressure is impractical; and achieving 60% power and a 4500°R chamber temperature by using SSCSS worth alone is impractical. A significant SSCSS design change would be required to achieve either complete proportional δk control with SSCSS worth (assuming a 60%-power requirement) or a reduction in flow impedance for cooldown purposes. The effect of such a change on performance, reliability, weight, and schedule should be determined. (auth)

**30270** (RN-PA-0012) AEROJET PRESENTATION TO THE NERVA SHIELDING ADVISORY COMMITTEE AT GERMANTOWN, MARYLAND. (Aerojet-General Corp., Sacramento, Calif. (USA)). 29 Nov 1967. 150p. Dep. NTIS $10.50.
Declassified 19 Sep 1975.
It is recommended that the Shielding Advisory Committee recognize that to design the engine and its components responsibly requires an intensive activity in both systems studies and radiation analysis. (auth)

**30271** (RN-S-0309(Suppl.)(Bk.4)) NRX/EST DATA ANALYSIS REPORT. Supplement, Book 4. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1966. 384p. Dep. NTIS $22.25.
Declassified 19 Sep 1975.
The multiple plots conceived and generated by REON during the NRX/EST series are presented. These plots have advanced the state-of-the-art in the presentation of data for analysis purposes by: (1) Providing up to seven distinct parameters plotted against control room time per page as compared with the single parameter plot per page in CALCOMP format available during the NRX-A1 through the NRX-A3 test series. With several parameters plotted on a single page, a ready comparison of the performance of the various parts of the engine was possible. (2) Making the multiple plots available to the DRAGON team within a 36-hour period after the conclusion of EP-IIB, IIC, and IV, it was possible for the DRAGON team to analyze engine performance by reviewing pertinent data with a minimum of delay and to make recommendations for the next test. (3) Making plots of the entire test time period as in EP-IVA. Thus, a survey of the entire test period was accomplished whereas in early tests only abbreviated time periods, such as shutdown and startup, were produced on CALCOMP plots. (4) Reducing the overall volume of material to be reproduced, distributed, and stored. Because REON Systems Analysis was able to make extensive use of the multiple plots, a much more detailed data analysis report was issued on NRX/EST within the allotted time period. (auth)

**30272** (RN-S-0514) XE-PRIME COMMON ANALOG MODEL. Pfremmer, R. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1969. Contract SNP-1. 86p. Dep. NTIS $7.50.

Declassified 24 Sep 1975.

The analog model equations for the ETS-1 facility and the XE-Prime engine are presented. Steady-state and dynamic characteristics of the equation solutions are included. (auth)

**30273** (TID/SNA-2040) NERVA STARTUP COMMON ANALOG MODEL EQUATION DERIVATIONS. Dryden, R. M. (Aerojet Nuclear Systems Co., Azusa, Calif. (USA)). Jun 1972. 178p. Dep. NTIS $12.00.

Declassified 14 Jul 1975.

The Start-Up CAM was derived to be used in the start-up region of the NERVA engine system. The start condition of the Start-Up CAM was after a pressure chill from an ambient temperature of 400°R, and the upper limits were chamber temperature and pressure of 1500°R and 100 PSIA, respectively. Some of the assumptions are valid only in this region of operation. The nozzle coolant tube heat transfer was the same as the full power CAM because of lack of data from the digital computer engines analyses. Data obtained from the Start-Up CAM indicates that the turbine inlet temperature is a very important parameter. This information indicates the nozzle heat transfer should be updated. The species of hydrogen in the NERVA engine is assumed to be parahydrogen. The ultimate source of all the parahydrogen properties used in this model is the National Bureau of Standards Generating Codes. These codes consist of a complex set of equations which furnish all of the hydrogen properties for an input state point. These codes are far too slow to be useful in a hybrid or in most digital simulations. Tabulated data generated by these codes are, therefore, used as a source of specific properties. The equations used are given, the variables are defined and units specified; assumptions and background information are given when necessary. (auth)

**30274** (TID/SNA-2048) NONDESTRUCTIVE TESTING OF FUEL ELEMENTS. Tenney, G. H. (Los Alamos Scientific Lab., N. Mex. (USA)). 1962. 13p. Dep. NTIS $4.00.

Declassified 24 Sep 1975.

Nondestructive testing of fuel elements during fabrication is described. Two tests are described in some detail: radiography and gamma scans. Dimensional inspection, gamma counting of mixed feed materials, etc. are mentioned. (LTN)

**30275** (TID/SNA-2148) PHOEBUS PRESENTATION. Phoebus-1-322 Design. Cooper, K. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). 18 Feb 1965. 16p. Dep. NTIS $4.00.

Declassified 29 Sep 1975.

**30276** (TID/SNA-2252) MINUTES OF THIRD MEETING OF NERVA TECHNICAL COMMITTEE AT LAS VEGAS AND NTS, NEVADA. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1961. 13p. Dep. NTIS $4.00.

Declassified 24 Sep 1975.

**30277** (TID/SNA-2267) TEST CELL "C" MODIFICATIONS. Phoebus Presentation. Boyer, K. (Aerojet-General Corp., Sacramento, Calif. (USA)). 18 Feb 1965. 23p. Dep. NTIS $4.25.

Declassified 29 Sep 1975.

Modifications to Test Cell "C" required for PHOEBUS reactor testing are described. Mainly, these involve large increases in liquid hydrogen capacity and flow rate, liquid nitrogen capacity and hot water storage and flow rate. In addition, considerable changes in the control systems are involved. (LTN)

**30278** (TID/SNW-125) TRANSMITTAL OF CALCULATED PIN LEAKAGES FOR A-11 TEST NE8010B. Gormley, O. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 12 Dec 1963. 9p. Dep. NTIS $4.00.

Declassified 14 Jul 1975.

Pin leakages have been calculated for the A-11 test configuration for several assumed pin clearances. This has been done to provide the required information for the sizing of orifices to simulate pin clearance flow. The cases analyzed are listed and are believed to encompass the entire range of the pin clearance effect. Pin clearance has a profound effect on the total flow from the spring chambers into the lateral support system. The flows reported are those entering the lateral support system from the spring chambers for the individual seal rings which have 12 pins each. The total flow entering the lateral support system from this source could be obtained by summing the flow from each of the 18 individual seal rings reported. The effect of the variation in pin clearance flow on the axial distribution of static pressure between seals is shown. The difference is most pronounced at the higher leakage rates and results from the addition of extra flow to the system along the main flow path. (auth)

**30279** (TID/SNW-133) NERVA NUCLEAR ROCKET ENGINE. Volume II. Engine Design. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1961. 417p. Dep. NTIS $24.00.

Declassified 23 Sep 1975.

This proposal submitted by the Westinghouse Electric Corporation to the AEC-NASA Nuclear Propulsion Office is based on an evaluation of the technical aspects of the proposed NERVA program. The conclusions from this evaluation are: through the pioneering efforts of the Los Alamos Scientific Laboratory in the Rover program, the basic feasibility of the nuclear reactor for the engine has been demonstrated; the basic materials properties of the reactor fuel elements have been solved, and temperatures may be achieved which give excellent vehicle performance; the NERVA engine can be designed with sufficiently low weight to permit useful missions when incorporated in a compatible vehicle; the reactor dynamics and control problems can be solved successfully; and the development of the other major components, while difficult, can be accomplished with a vigorous development program. From these analyses, Westinghouse is convinced that the NERVA program is sound, feasible, and within the Westinghouse resources for accomplishment. (LTN)

**30280** (TID/SNW-134) NERVA NUCLEAR ROCKET ENGINE. Volume III. Program Concepts. Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 3 Apr 1961. 193p. Dep. NTIS $12.75.

Declassified 23 Sep 1975.

Westinghouse discusses the principal problem areas visualized in the proposed nuclear rocket development, presents a detailed program, with emphasis on reliability, and outlines their proposed initial research and development efforts. (LTN)

**30281** (TID/SNW-136) PRIME EQUIPMENT DETAIL SPECIFICATION PERFORMANCE/DESIGN AND PRODUCT CONFIGURATION REQUIREMENTS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 28 Apr 1967. 134p. Dep. NTIS $9.75.

Declassified 24 Sep 1975.

**30282** (WANL-TME-573) CONTRACT YEAR 1963. Technical Summary Presentation, October 22–23, 1963. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Oct 1963. 431p. Dep. NTIS $24.75.

Declassified 11 Sep 1973.

The document is a transcript of presentations by the sponsors of the NERVA Nuclear Subsystem projects described in WANL Work Program WANL-WP(J)-017 (May 17, 1963). These talks were given at a meeting held at WANL on October 22 and 23, 1963 to review program progress in Contract Year 1963. The agenda gives the order in which the projects were discussed, which is also the order in which they were printed. (auth)

**30283** (WANL-TME-880) POWER CAPABILITY AND TEST PROFILE ANALYSIS FOR THE NRX-A2 REACTOR. Lescisin, J. J.; Buskirk, D. L.; Zemanick, P. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1964. 130p. Dep. NTIS $9.50.

Declassified 14 Jul 1975.

The power and test profile capability of the NRX-A2 reactor are determined, based on operation at conditions which have been demonstrated to be within the capabilities of the design. Justification for the entire test profile is presented. Component tests, as-built core data, and design analysis which determined core limitations are described. Fuel element corrosion test data was used to conservatively determine the temperature-time capability of the as-built core. The analysis indicates that the maximum hold power, flow, and time should be 850 MW (76 percent of full power), 71.3 lb/sec and 4.6 minutes, respectively. For this profile, it is recommended that the drum angle and thermal and fluid flow quick look data be observed during the first two minutes of the hold and adjustments made in the hold time for variation in drum angle. The suggested adjustment in operating time at the 76 percent power level as a function of drum angle variation is presented. (auth)

**30284** (WANL-TME-1667) NERVA TECHNICAL PROGRAM REVIEW, WANL-LARGE, PENNSYLVANIA, AUGUST 23–24, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Sep 1967. 275p. Dep. NTIS $16.75.

Declassified 12 Sep 1973.

Diagrams, graphs and slides presented at NERVA technical program review at Large, Pa., Aug. 23–4, 1967, have been documented. (LTN)

**30285** (WANL-TME-1676) WANEF CRITICAL EXPERIMENTS IN SUPPORT OF NERVA. Quarterly Report, 2nd Quarter CY '67. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1967. 120p. Dep. NTIS $9.00.

Declassified 12 Sep 1973.

The reactivity worth of beryllium has been measured in the NRX-A6 quadrant of the PAX-E assembly in the region between the lateral support mockup and the outer reflector. Both "thick" and "thin" beryllium liner plates were used in the measurements. Graphite reactivity worths were measured in the reflector mockup quadrant utilizing graphite liner plates and rods. These measurements using NRX-A6 and PAX fuels in the core part of the quadrant are tabulated. The control instrument response of the EMND (Engine Mounted Neutron Detector) was obtained on the PAX-E reactor. The environment closely simulated that expected during the testing of XE-1 at NRDS. The procedures for the experiment consisted of measuring the detector (WX-5362) output per watt of reactor power and the gamma dose rate per watt for the variation of experimental conditions. The conditions included the determination of the effect of hydrogen between the dome and detector on detector output and gamma dose rate; and the effect of cadmium on detector output and gamma dose rate (and combinations of the two). Eleven configurations were investigated, varying these parameters and the presence of a mockup of the privy roof. (auth)

**30286** (WANL-TME-1696) INVESTIGATIONS ON LOSSES OF FISSION PRODUCTS BY DIFFUSION AND BY HYDROGEN-INDUCED CORROSION FROM NERVA FUELS. Roesmer, J.; Henninger, W. A.; Rymer, G. T. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1967. 88p. Dep. NTIS $7.50.

Declassified 10 Sep 1973.

The experimental and analytical work performed on the fission product diffusion program is described. The fission product diffusion program has as its objective the determination of a source term applicable to the full power testing of the NRX, XE, and NERVA reactors. The source term is defined as the magnitude of the fission product inventory generated and contained within the reactor, together with the magnitude and physical nature of fission product activity released from the reactor. Fission products leave the core of an operating NERVA reactor by the following paths: Release by diffusion from uncoated fuel element faces, release by diffusion from Mo-NbC coated fuel channels, and loss as particulate matter resulting from the corrosive action of hydrogen on graphite. In view of the possible paths for fission product release, diffusion studies have been carried out on uncoated, NbC coated, and Mo-NbC coated triplex fuel samples. In addition, preliminary studies have been undertaken on the loss of particulate matter by corrosion from Mo-NbC triplex fuel elements. As a result of the studies described the following conclusions can be made: Fission product diffusion as a function of temperature can be represented by the Arrhenius equation; error analysis of the diffusion data at a 95% confidence interval gives a maximum error of ± 50% in values of E and ± 63% in values of $D_0$; NbC coating inhibits the release of some fission products from triplex fuel but an overlay of molybdenum coating causes no additional reduction in fission product release; and a minimum release of $4.7 \times 10^6$ curies and a maximum of $1.2 \times 10^7$ curies of gross fission products are expected during the NRX-A6 reactor test. (auth)

**30287** (WANL-TME-1701) POST-OPERATIONAL HEATING ANALYSIS OF NR-1, II. Trammell, M. R.; Bridges, J. M.; McCune, W. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Nov 1967. 89p. Dep. NTIS $7.50.

Declassified 10 Sep 1973.

If the propellant (coolant) flow to a NERVA reactor is suddenly disrupted during the course of a mission, some severe effects on the reactor will result. These effects may or may not result in a radiological hazard to the Earth's population—but the conditions under which the disruption occurs and the condition of the reactor and its radioactive inventory subsequent to the loss of coolant must be known to assess the magnitude of this possibility. New calculations of the temperature distributions developing in the beryllium reflector and the axial and lateral support systems are reported. Previous studies have indicated that one of the primary mechanisms of heat loss and heat transfer in the NERVA reactor core under loss of coolant conditions results from sublimation. The reason for the importance of graphite sublimation as a heat loss, heat redistribution mechanism lies in the very large heat of sublimation associated with this process, 5,000 cal/g (~9,000 BTU/lb). Not only is the sublimation process an important one in the prediction of post operational temperature profiles, it is also an exceedingly complex one. The importance of developing a reasonable model to predict graphite sublimation and relocation rates under the post operational heating conditions encountered in the NERVA reactor thus becomes apparent. (auth)

**30288** (WANL-TME-1722) NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING HELD WITH SNPO AT WANL ON NOVEMBER 30, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 50p. Dep. NTIS $5.50.

Declassified 10 Sep 1973.

Testing during the period was mainly involved with fuel elements and fuel element clusters in support of the NRX-A6, XE-PRIME and XE-2 reactors. A few tests involved miscellaneous other reactor components. (LTN)

**30289** (WANL-TME-1733) PRESENTATION TO SNPO-C NUCLEAR AND RADIATION DEVELOPMENT PROGRAM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 14 Aug 1967. 99p. Dep. NTIS $8.00.

Declassified 10 Sep 1975.

The presentation made to SNPO-C on the Nuclear and Radiation Development program associated with the PFRT program has been documented. It deals mainly with criticality mockups of proposed reactors and the determination of needed information: radiation doses, radiation heating, shielding and reactor characteristics with such systems. (LTN)

**30290** (WANL-TME-1978) FISSION PRODUCT DIFFUSION FROM NERVA FUEL AT LOW TEMPERATURES. Roesmer, J.; Henninger, W. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1969. 34p. Dep. NTIS $4.79.

Declassified 10 Sep 1973.

One of the postulated initial NERVA missions will be to ferry men and material from an earth orbit of about 100 nautical miles to a synchronous orbit at 22,000 nautical miles, which would require several burn periods of five to ten minutes duration and long coasting periods of up to several hours. During the coasting periods, while the reactor is shut down, the core will heat up because of the fission product decay heat. To prevent meltdown of critical components, the core will be periodically cooled to an average temperature of 560°C (1500°R). During these coasting periods of time durations up to 48 hours, release of the more mobile fission products may occur at 560°C (1500°R) and may be a potential radiation hazard to the vehicle crew. For any calculation of the dose rate, knowledge of the magnitude and composition of the fission product release is prerequisite. Rather than extrapolate diffusion data obtained at a temperature range 1900 to 2300°C and time periods up to 60 minutes, a series of diffusion experiments was initiated in lower temperature, longer time period conditions. The low-temperature diffusion constants permit a more accurate prediction of the fission product release to be expected during the pulse-cooling periods than one would obtain by extrapolating the high-temperature constants used for NERVA full-power runs. A significant result is that the low-temperature constants are not a linear extrapolation of the well known high temperature constants. Using these measured low temperature constants, a 0.89 percent cumulative release of gross gamma activity is predicted during the entire synchronous orbit ferry mission discussed. The fission product release of candidate R-1 fuel beads suggests that fission product release depends upon the thickness of the coatings around the $UC_2$ kernels. (auth)

**30291** (WANL-TNR-166) NRX-A5: COMBINED REACTOR AND SYSTEM TESTING IN TEST CELL A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 13 Jul 1964. 31p. Dep. NTIS $4.75.

Declassified 14 Jul 1975.

A proposal is developed to supplement NRX reactor testing by simultaneously obtaining key engine systems information. The scheme is based on the premise that successful KIWI B4 and NRX tests through A4 will result in a high degree of confidence in the reactor capability and that, following these early successful tests, great benefit will be derived from supplementing the tests planned for the NRX-A5 reactor with additional testing using a closed loop system simulating the NERVA engine system. The primary information desired from supplementary tests of this type is the assurance that the bootstrap startup of a system similar to the engine is possible. In addition, it is desired to test certain key engine components. Even if the ultimate capabilities of the engine parts are not approached, it will be significant to show that the system functions properly. A demonstration of a hot bleed system and a bootstrap startup would be of great value even if the maximum power attained in the closed loop portion of the testing were at 40 percent of the reactor rating. The proposal is developed in detail with respect to objectives, modifications necessary and costs. (auth)

**30292** (WANL-TNR-209(Vol.2)) ROVER FLIGHT SAFETY PROGRAM PRELIMINARY REVIEW. Volume II. Bridges, J. M.; Brown, W. S.; Call, D. W.; Cleary, J. D.; Hargrove, H. G.; Trammell, M. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 30 Sep 1965. 450p. Dep. NTIS $25.50.

Declassified 31 Jul 1975.

An analysis has been made to predict the behavior of a nuclear rocket engine in the event of an in-flight failure subsequent to startup of the nuclear stage. The accident model chosen for analysis assumed loss-of-coolant to the reactor at time of system failure. It has further been assumed that the only direct action taken subsequent to failure is separation of a re-entry vehicle from the remainder of the stage. This vehicle consists of the reactor, pressure vessel, and nozzle. The behavior of the vehicle during its residence time in space and during its re-entry into the Earth's atmosphere is examined and described for three different missions. Two of these are lunar missions employing a NERVA-I class engine, and the third is a Mars fly-by using a NERVA-II class engine. The potential exposure of the Earth's population to nuclear radiation is presented for each of the three missions. (auth)

**30293** (WANL-TR-6601) REVIEW THE TECHNICAL PROGRESS ON LONG LIFE REACTOR (LLR) DESIGN EFFORT. Exchange Technical Progress in Materials Development for the NERVA Reactor. Holman, R. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Feb 1971. 16p. Dep. NTIS $4.00.

Declassified 11 Jul 1975.

A variety of items are reported after a trip to LASL. Design features of the PEWEE-3 reactor are reported. The fabrication of zirconium carbide received considerable attention. The mechanical and physical (thermal conductivity) properties of fabricated specimens are reported. The performance of fuel elements is discussed, especially with respect to cracks in the coatings. Many other items are discussed briefly. (LTN)

**30294** NAVAL NUCLEAR PROPULSION PROGRAM, 1975. Hearing Before the Subcommittee on Legislation of the Joint Committee on Atomic Energy, Congress of the United States, Ninety-Fourth Congress, First Session on ERDA Fiscal Year 1976 Authorization for the Naval Nuclear Propulsion Program, March 5, 1975. Washington, DC; Joint Committee on Atomic Energy (1975). 124p. GPO $1.55.

**30295** TECHNISCHE UND WIRTSCHAFTLICHE AUSSICHTEN DES NUKLEAREN SCHIFFSANTRIEBS. Bd. 1. Text. (Technical and Economic Prospects of Nuclear Ship Propulsion. Vol. 1. Text). Bruegel, P.; Ernst, H.; Maurath, K.; Roth, E.; Tornier, W.; Zakrocki, H. (comps.). Stuttgart; Fichtner Beratende Ingenieure(1974). vp.

With figs. and refs.

Appropriate cargo groups and freight routes are taken from a transport capacity prognosis. The merchant shipping is optimized for various propulsion systems and the sensibility to variation of basic data investigated. The competitive influence of other transport systems is considered. Nuclear propulsion is of significance chiefly for container ships covering long distances and for tankers. The development of oil prices is the most uncertain factor (probable escalation 4-5% p.a.). Over the next 35 years, world-wide potential could amount to 1,000 nuclear propulsion units with ratings of 60,000-120,000 SHP. (auth)

**30296** TECHNISCHE UND WIRTSCHAFTLICHE AUSSICHTEN DES NUKLEAREN SCHIFFSANTRIEBS. Bd. 2. Beilagen. (Technical and Economic Prospects of Nuclear Ship Propulsion. Vol. 2. Appendix). Stuttgart; Fichtner Beratende Ingenieure (1974). vp.

With figs. and tabs.

## Reactor Safety and Environmental Aspects

*Refer also to abstracts 27927, 27930, 27966, 27967, 28431–28434, 30132, and 30217.*

**30297** (AAEC/E-342) OWEN-1: A CODE FOR ANALYSIS OF TWO-PHASE COMPRESSIBLE FLOW TRANSIENTS IN A SINGLE CHANNEL. Turner, W. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1975. 44p. Dep. NTIS $5.25.

A computer code for simulating two-phase compressible flow transients including loss-of-coolant in a single water cooled channel is described. The momentum flux term is included and slip between the phases is allowed. A pipe model and detailed surface heat transfer is included. The conservation equations are solved by means of an implicit numerically stable finite difference scheme so that time step size can be chosen on accuracy considerations alone. (auth)

**30298** (AD-739704) ECOLOGICAL EFFECTS OF OFFSHORE CONSTRUCTION. Rounsefell, G. A. (Marine Science Inst., Bayou La Batre, Ala. (USA)). 1972. Contract DACW-72-71-C-0002. 217p. Marine Science Inst., Bayou la Batre, AL $2.00.

Published in J. Mar. Sci.; 2: No. 1, 1-89; A1-A119(1972).

The report evaluates current knowledge of the probable ecological effects of various types of offshore construction. The greatest dangers seem to lie in the placement of artificial islands within or too closely adjacent to estuaries where they can significantly affect water exchange, and in the proliferation of water cooled nuclear power plants. The effects on marine biology and water quality are discussed. Included is an annotated bibliography of 284 references. (GRA)

**30299** (ANCR-1216) TWO-PHASE FLOW VELOCITY MEASUREMENT WITH RADIATION INTENSITY CORRELATION. Lassahn, G. D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Jun 1975. Contract E(10-1)-1375. 31p. Dep. NTIS $4.00.

Two-phase flow velocities can be measured by correlating radiation attenuation, radiation emission, or radiation scattering at several positions along the pipe length. This report gives a description of a basic two-phase flow velocity measuring system and some variations of that system. A mathematical treatment of the basic system and a description of a simple experimental confirmation of the principle are also included. (auth)

**30300** (ANCR-1230) SEMISCALE MOD-1 PROGRAM AND SYSTEM DESCRIPTION FOR THE BLOWDOWN HEAT TRANSFER TESTS (TEST SERIES 2). Feldman, E. M.; Olson, D. J. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Aug 1975. Contract E(10-1)-1375. 54p. Dep. NTIS $5.45.

A reference is presented for the experiment data reports and the topical analysis reports prepared for the Semiscale Mod-1 blowdown heat transfer test series (Series 2). This test series is part of the Semiscale Mod-1 Program conducted by Aerojet Nuclear Company for the United States Government. Presented are descriptions and objectives of the overall Semiscale Mod-1 Program and of the blowdown heat transfer test series; a discussion of core operation considerations; descriptions of the Mod-1 system configuration, test conditions, and test procedures for the blowdown heat transfer test series; and descriptions of the Mod-1 data acquisition and processing system used to acquire, process, and present the data reported in the data reports for that series. (auth)

**30301** (ANCR-1232) EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1 TEST S-02-2 (BLOWDOWN HEAT TRANSFER TEST). Crapo, H. S.; Jensen, M. F.; Sackett, K. E. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Aug 1975. Contract E(10-1)-1375. 74p. Dep. NTIS $5.45.

Recorded test data are presented for Test S-02-2 of the Semiscale Mod-1 blowdown heat transfer test series. Test S-02-2 was conducted from an initial cold leg fluid temperature of 542°F and an initial pressure of 2,260 psig. A simulated double-ended offset shear of the cold leg initiated the test to investigate the system response to a depressurization transient with a moderately heated core (75 percent design power level). The electrically heated core was used in the pressure vessel to simulate the effects of a nuclear core. The flow resistance of the intact loop was based on core area scaling. During system depressurization, core power was reduced from the initial level of 1.2 MW in such a manner as to simulate the surface heat flux response of the LOFT nuclear fuel rods until such time that departure from nucleate boiling (DNB) occurs. Blowdown to the pressure suppression system was accomplished without simulated emergency core coolant injection or pressure suppression system coolant spray. (auth)

**30302** (ANCR-1248) THERMAL FUELS BEHAVIOR PROGRAM TEST RESULTS REPORT. Power-Coolant-Mismatch Series Power Calibration Test. McCardell, R. K.; Cawood, G. W.; Allison, C. M.; Frederick, C. G. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Jul 1975. Contract E(10-1)-1375. 55p. Dep. NTIS $5.45.

The first experiment in the PCM-20 Test Series, the power calibration test, is described. The objectives of the experiment were to relate the PBF core power to the power in the PCM-20 test rod, evaluate the loop system, and evaluate the hardware, instrumentation and data acquisition system used for the PCM-20 tests. The test rod peak linear power was determined by radiochemical analysis and a thermal-hydraulic energy balance. 7 references. (auth)

**30303** (ANCR-1254) QUARTERLY TECHNICAL REPORT ON WATER REACTOR SAFETY PROGRAMS SPONSORED BY THE NUCLEAR REGULATORY COMMISSION'S DIVISION OF REACTOR SAFETY RESEARCH, JANUARY–MARCH 1975. (Aerojet

Nuclear Co., Idaho Falls, Idaho (USA)). Sep 1975. Contract E(10-1)-1375. 155p. Dep. NTIS $7.60.

The Semiscale Program consists of a continuing series of small-scale nonnuclear thermal-hydraulic experiments having as their primary purpose the generation of experimental data that can be applied to the development and verification of analytical models describing loss-of-coolant accident (LOCA) phenomena in water-cooled nuclear power plants. The current program of experiments employs a recently assembled test system, Semiscale Mod-1, which has one intact (operating) loop with active components and a broken (blowdown) loop with passive components. These experiments include isothermal blowdown tests (no core heating) and blowdown heat transfer and core reflood tests using an electrically heated 40-rod core. The LOFT facility is in the final stages of construction. The test programs, planned to start in late 1975, include a series of nonnuclear (without nuclear heat) LOCEs followed by a series of low-power nuclear LOCEs and then a series of high-power nuclear LOCEs. The Thermal Fuels Behavior Program is an integrated experimental and analytical program designed to provide information on the behavior of reactor fuels under normal, off-normal, and accident conditions. The experimental portion of the program is concentrated on testing of single fuel rods and fuel rod clusters under power-cooling-mismatch (PCM), loss-of-coolant and reactivity initiated accident conditions. The Reactor Behavior Program encompasses the analytical aspects of predicting the response of nuclear power reactors under normal, abnormal, and accident conditions. Program areas include advanced code development, fuel code development, code verification, and code optimization. (6 references) (auth)

**30304** (BMI-1936) REACTOR SAFETY PROGRAM APPLICATIONS AND COORDINATION. Task 1. Steam–Water Mixing Program and System Hydrodynamics. Quarterly Progress Report for April–June 1975. Cudnik, R. A.; Flanigan, L. J.; Denning, R. S. (Battelle Columbus Labs., Ohio (USA)). Aug 1975. Contract W-7405-eng-92. 38p. NTIS $4.00.

Experimental studies to extend the understanding of steam-water interaction phenomena and processes associated with a loss-of-coolant accident are described. Experimental studies of plenum filling were conducted in the 1/15-scale transparent vessel model. The remainder of the coupled penetration studies (ECC water injection with cold-leg steam) planned for FY 1975 were carried out, thus completing the data base needed for future data comparisons. In these studies, an effect of lower-plenum liquid level on water penetration to the plenum was identified. It was found that at a fixed, reverse core steam flow rate, increasing the lower-plenum water level decreased the penetration rate. Penetration studies were conducted to assess the effect of annulus vanes on water penetration to the lower plenum. The effect of vanes spanning the full length and ¼ of the length of the core barrel was determined. Both vane lengths increased the water penetration as compared with the no-vane case, with the full-length vanes being more effective than the ¾-length vanes. Scoping studies of water entrainment from the lower plenum by reverse core steam flow were also carried out in the transparent model. Modifications to the transparent vessel facility were initiated to provide a means for investigating the effect of hydraulic communication between the multiple, intact, cold-leg and core steam supplies on plenum filling. A new core barrel, insulating liner, and hot-leg simulators have been fabricated to provide the transparent vessel with a 1-inch annulus-gap-width capability. A new transparent belt section has been procured, and a new core barrel and hot-leg simulators have been fabricated to model the B and W cold leg and direct annulus injection geometry in the transparent vessel facility. The design and fabrication of a 1/15-scale steel vessel system for plenum-filling studies in the range of 60 to 70 psig were initiated. (auth)

**30305** (BNL-50450) HTGR SAFETY EVALUATION DIVISION QUARTERLY REPORT, JANUARY 1, 1975–March 31, 1975. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 86p. Dep. NTIS $4.75.

Research progress is reported on the following: fission product release and transport, primary coolant impurities, rapid graphite oxidation, structural evaluation, materials, instrumentation and monitoring, accident delineation, and phenomena modeling and systems analysis. (JWR)

**30306** (CENPD-168) DESIGN BASIS PIPE BREAKS FOR THE COMBUSTION ENGINEERING TWO LOOP REACTOR COOLANT SYSTEM. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jul 1975. vp. Combustion Engineering, Inc. Windsor, CT.

The criteria and analytical methods used to establish the design basis for the mechanical effects of postulated pipe ruptures in the C-E two loop reactor coolant system piping are described. Methods and results are presented for the determination of the most likely break locations throughout the RCS piping system, the most likely break type (circumferential severance or longitudinal slot) at each assumed break location, and break characteristics such as orientation, size, and break opening time. The criteria for locating and defining the various breaks are sufficiently conservative to provide a high level of protection against pipe whip, jet impingement, subcompartment pressurization, and component loadings from a significant number of pipe breaks in addition to the specific postulated pipe breaks. 15 references. (auth)

**30307** (CONF-751101-5) NEEDS FOR REACTIVITY ANOMALY MONITORING IN CRBRP. Bullock, J. B. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Two general classifications of reactivity anomalies are defined and explicit design criteria and operational philosophy for an anomaly monitoring system for the Clinch River Breeder Reactor are presented. (JWR)

**30308** (ERDA-tr-37) THERMOHYDRODYNAMIC BEHAVIOR WITHIN PRIMARY COOLANT SYSTEM DURING COOLANT LOSS INCIDENT OF A LIGHT WATER REACTOR. Final Report on ROSA-I Blowdown Test. Shimamune, H.; Antatsu, T.; Namatame, K.; Okubo, K.; Chiba, Y.; Ito, H.; Wakijima, S.; Yamamoto, N.; Kinami, M.; Toda, S. Mar 1974. Translation of JAERI-Memo-5662. 283p. Dep. NTIS $7.60.

The ROSA-I plan was executed to elucidate the thermohydrodynamic behavior within the primary coolant system at the time of a coolant loss incident that is one of the maximum credible incidents associated with a light water cooled nuclear reactor. Tests on the ROSA-I plan were initiated in December 1970, and a total of 61 rounds of release tests were completed in March 1973. The experimental equipment used in the tests, the experimental data, and the experimental results are presented. 44 references. (auth)

**30309** (ERDA-tr-61) SAFETY SYSTEMS IN FAST REACTORS. Argous, J. P. Translation of French Report 13p. (CONF-750411-42). Dep. NTIS $4.00.

From European nuclear conference; Paris, France (21 Apr 1975).

The safety systems used in fast reactors are reviewed. The objectives pursued with these systems are indicated and details are given of present studies aiming at an improvement of the performance and reliability of these systems. (auth)

**30310** (EURFNR-1254) SENSITIVITY STUDIES FOR FAST REACTOR WHOLE CORE ACCIDENTS. Evard, G.; Froehlich, R.; Renard, A.; Schmuck, P.; Stievenart, M.; Thiem, D. Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. Fuer Neutronenphysik und Reaktortechnik. Mar 1975. 47p. (KFK-2086). Dep. NTIS (US Sales Only) $4.00.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The energy yield of a hypothetical transient overpower accident of an LMFBR is strongly influenced by core design parameters. The sensitivity of this type of accident on some interesting design parameters is studied for the fresh SNR 300 Mark 1 core. In addition the sensitivity of the energy yield on other parameters of more speculative nature, e.g. the fuel coolant interaction parameters and the pin failure location is analyzed. The codes CARMEN 2 and KADIS are used for the analyses of the predisassembly and disassembly phases respectively. Most of the parameter variations are performed consistently for the predisassembly and the disassembly phases. Areas are indicated where further experimental and theoretical work is needed. 7 references. (auth)

**30311** (GA-A-13397) SEISMIC MODEL OF THE GAS-COOLED FAST BREEDER REACTOR CORE SUPPORT STRUCTURE. Penzes, L. E.; Chang, K. H.; Lee, G. E. (General Atomic Co., San Diego, Calif. (USA)). 15 Aug 1975. Contract AT(04-3)-167. 15p. (CONF-750908-6). Dep. NTIS $4.00.

From 3rd international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A new modeling technique for the seismic analysis of the GCFR core support structure is under development. With the new technique one can determine what effect a large number of core elements, hanging as cantilevered beams from a perforated grid plate, have on the grid plate vibration. With this technique, the amplitudes and stresses of individual core elements can be computed. This method also permits the study, in a realistic manner, of the relative motions between the individual core elements. The analysis of the core support structure is divided into three steps: (1) Analysis of the grid plate; (2) Analysis of the core elements; and (3) Modal synthesis. The dynamic behavior of the grid plate and its influence on the seismic analysis is ex-

amined. The analysis of the fuel and blanket elements and the method of modal synthesis are also discussed. (auth)

**30312** (GA-A-13513) GCR SAFETY PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1975. (General Atomic Co., San Diego, Calif. (USA)). 31 Jul 1975. Contract AT(04-3)-167. 84p. Dep. NTIS $5.45.

The program covers development of safety and safety-related studies to better understand and more accurately define safety characteristics and safety margins of GCRs under postulated accident conditions. The work reported here includes core seismic studies, high-temperature gas-cooled reactor (HTGR) accident initiation and progression analysis, the setting up of a reliability data bank, safety liaison with RRD-selected contractors, and safety research on core-released radioactivity, secondary containment gas flammability, and containment atmosphere response during postulated accident situations. (auth)

**30313** (GEAP-13923-11) SAFETY ENGINEERING. Eleventh Quarterly Report, February–April 1975. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jun 1975. Contract AT(04-3)-893. 40p. AT.

The objective of the work reported under this program is to provide an independent evaluation of existing experimental data and analytical models relating to design and safety analysis of LMFBR cores, and to identify requirements for additional model development and testing in support of long-term LMFBR safety evaluations. Progress during February, March, and April 1975 is described. (auth)

**30314** (GEAP-14023-3) SAFETY ASSESSMENT. Third Progress Report, December 1974 and January–February 1975. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Mar 1975. Contract AT(04-3)-893. vp. AT.

LMFBR risk assessment methods development and evaluations included the following activities: (1) Development of a work plan which extends the current application of FTR to include applications of early LMFBRs in order to estimate the risk worth of information uncertainties, design variations and operating procedures; (2) Development of probability models for quantification of Module 1 which describes an accident from its initiation to its effect on the reactor core, and Module 2 which describes the accident progression from a state of core degradation to radioactivity release from containment; (3) Analysis of the statistical and time dependence of probabilities involved in Module 1 for the FTR application; (4) Analysis of the FFTF primary coolant boundary failure; and (5) Analysis of the FFTF radioactivity containment. A probabilistic model of pipe failures in LMFBR primary piping was developed. This model combines the results of fracture mechanics analysis of crack propagation into a probabilistic failure analysis. The failure model uses various initial conditions of the pipe material combined with operating loads to calculate the possible damage propagation. The probabilistic model then represents the overall failure process by combining these individual calculations based on the various initial conditions. The analysis thus considers many variations and combinations of data to determine probability of failure during the reactor lifetime either from a leak or a break. (auth)

**30315** (GEAP-14034-3) RADIOLOGICAL ASSESSMENT MODELS THIRD QUARTERLY REPORT, MARCH–MAY 1975. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jun 1975. Contract AT(04-3)-893. 58p. AT.

The objectives of this program are to develop models for analyzing and evaluating postulated radiological sources, aerosol dynamics, sodium fires, and radiological dosages arising in the hypothetical core disruptive accident of liquid metal fast breeder reactor. The work performed during this reporting period continued the review and evaluation of current technology, experiments, analytical models, and computer codes used in radiological modeling and assessment. The immediate objective is to develop a preliminary, over-all radiological assessment model for the hypothetical core disruptive accidents. (auth)

**30316** (GEAP-14038-2) ADVANCED SAFETY ANALYSIS. Second Quarterly Report, December 1974 and January–February 1975. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Mar 1975. Contract AT(04-3)-893. vp. AT.

LMFBR safety-related studies are reported in the areas of shutdown system reliability, inherently safe core design, fuel pin failure mechanisms, and post-accident heat removal. (JWR)

**30317** (INIS-mf-1236, pp 28-43) SOME ASPECTS RELATED TO MONITORING FOR INTERNAL CONTAMINATION IN NUCLEAR POWER PLANTS. Moldenhawer, F. (Staatliche Zentrale fuer Strahlenschutz, Berlin). 1972. (In German).

From Polish-German work group meeting; Warsaw, Poland (22 Jun 1970).

In radioactive pollution of environment. (Centralne Lab. Ochrony Radiologicznej, Warsaw (Poland)).

Handling of unsealed radioactive sources and working in conditions of frequent contamination of air and surfaces may give rise to intakes of radioactive material into the body, causing internal exposure. The results of air and surface monitoring and the evaluation of the risk of incorporation can be used to assess the need for monitoring for internal contamination. Taking the pressurized water reactor as an example origin and kind of contamination as well as principles of monitoring for internal contamination are investigated and discussed. (auth)

**30318** (INIS-mf-1236, pp 108-121) SYSTEMS OF ENVIRONMENTAL MONITORING AROUND NUCLEAR FACILITIES. Roehnsch, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). 1972. (In German).

From Polish-German work group meeting; Warsaw, Poland (22 Jun 1970).

In radioactive pollution of environment. (Centralne Lab. Ochrony Radiologicznej, Warsaw (Poland)).

The objectives of environmental monitoring as part of the safeguards of a nuclear facility may be accomplished by two different ways corresponding to two different systems: the operation-independent and the operation-related system of environmental monitoring. Technical and organizational conditions, components and function of these systems are explained and their advantages and disadvantages, especially with regard to the objectives of environmental monitoring are discussed. (auth)

**30319** (INIS-mf-1521, ppDunc1-Dunc32) APPLICATION OF EXPERIMENTAL HEAT TRANSFER DATA TO BOILING WATER REACTOR (BWR/6) LOSS-OF-COOLANT ACCIDENT ANALYSIS. Duncan, J. D.; Leonard, J. E. (General Electric Co., San Jose, CA). 1974.

From conference on heat transfer and the design and operation of heat exchangers; Johannesburg, South Africa (18 Apr 1974). (South African Inst. of Chemical Engineers, Johannesburg; South African Inst. of Mechanical Engineers, Johannesburg; Council for Scientific and Industrial Research, Pretoria (South Africa)).

The direct cycle boiling water reactor nuclear system is a steam generating system consisting of a nuclear core and an internal structure assembled within a pressure vessel, auxiliary system to accomodate the operational and safeguard requirements of the nuclear reactor, and necessary controls and instrumentation. Water is circulated through the reactor core, producing steam which is separated from recirculation water, dried in the top of the vessel, and directed to the steam turbine-generator. The turbine employs a conventional regenerative cycle with condenser deaeration and condensate demineralization. With a compatible balance of plant equipment, startup and operation of the reactor are not dependent upon outside sources of power. (INIS)

**30320** (INIS-mf-1640, pp 53-69) TRAPPING AND DESORPTION OF IODINE IN GRAPHITE-GAS REACTORS. Sigli, P. (CEN, Fontenay-aux-Roses, France). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973). (Commission of the European Communities, Brussels (Belgium)).

Operational measurements made in the six gas-graphite type reactors operated by the EDF have led to the assumption of the existence of iodine trapping by internal structures. For the purpose of confirming this hypothesis, an experiment was made on the Chinon-1 reactor. The experiment consisted of injecting radioactive iodine into the primary circuit and of studying the evolution of its concentration and physical chemical form. The results show that the transformation of molecular iodine into a penetrating form is very rapid. Rapidity of trapping by important internal structures was observed. Desorption was slow. (tr-INIS)

**30321** (INIS-mf-1640, pp 315-327) METHODS USED AT KEMA FOR MEASURING IODINE ADSORPTION ON CHARCOAL AND EXPERIENCES WITH CHARCOAL FILTERS INSTALLED AT A NUCLEAR POWER PLANT. Van der Lugt, G.; Scholten, L. C. (Keuring Van Electrotechnische Materialen N. V., Arnhem, Netherlands). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973). (Commission of the European Communities, Brussels (Belgium)).

At the KEMA reactor laboratory an installation is built for the measurement of the adsorption of iodine by small beds of charcoal. The temperature, humidity, dimensions of the bed and the flow velocity of the air in the bed are variable. A description of the apparatus is given, especially the differences with other similar installations. Methods for in-place testing of charcoal filters are described. Experiences with iodine filters

installed since 1968 at the Dodewaard nuclear power plant are given. Samples of charcoal used in these filters were measured periodically at the laboratory. (INIS)

**30322** (INIS-mf-1640, pp 329-351) IODINE FILTER TESTING IN SWEDEN. Hesboel, R.; Normann, B.; Devell, L. (Aktiebolaget Atomenergi, Studsvik, Sweden). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973). (Commission of the European Communities, Brussels (Belgium).

Charcoals and filters used for iodine removal in off-gases and ventillation ducts in nuclear power plants, and a hot cells laboratory are tested in laboratory and in-situ to investigate and check the proper behavior of installed filter systems. In normal procedures of testing only methyl iodine is used due to more critical removal properties for this compound. The need for careful installation of filters and preoperational and periodical testing is illustrated. The poisoning of charcoal by impurities in the air has been studied and some results are given. (INIS)

**30323** (INIS-mf-1640, pp 405-414) OPERATING EXPERIENCE OF THE SGHWR IODINE SORPTION SYSTEM. Clifton, J. J. (UKAEA Reactor Group, Winfrith, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973). (Commission of the European Communities, Brussels (Belgium)).

The prototype Steam Generating Heavy Water Reactor currently operated by the UKAEA at Winfrith in Dorset has two large ventilation clean-up plants as part of the normal operating and post-accident filtration system. Each clean-up plant is capable of dealing with 4,600 litres of air per second. A clean-up plant consists of particulate filters and a bed containing 2,600kg of charcoal which has been impregnated with chemicals to improve the retention of methyl iodide at high humidity. The performance of the charcoal is tested at routine intervals with radioactive methyl iodide. The tests are carried out in-situ at ambient humidities in the range 60 to 70% and in the laboratory at high (>98%) humidity. The design and layout of the SGHWP filter units, the method of testing and the operational test experience and mechanical performance during six years of continuous operation are described. Included is a brief description of the tests carried out on iodine filtration units installed in the extract ventilation system of a hot cell facility. (INIS)

**30324** (KFK-1901) RESI-1 AND RESI-2: PROTOTYPES OF AN INFORMATION SYSTEM ON REACTOR SAFETY. Schultheiss, G. F. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Apr 1975. 104p. (In German). Dep. NTIS (US Sales Only) $8.25.

To demonstrate by practical experience the feasibility of an information system on reactor safety, the prototype systems RESI-1 and RESI-2 were developed and tested. The RESI-1 prototype system is a paper version established for verification of all the individual functions before passing over to the computer-aided interactive version RESI-2. RESI-2 is based on the GOLEM system of Siemens. Both prototype systems have proved that the following essential features can be satisfactorily managed: documentation, formulation of and answering safety questions which are relevant with respect to particular licensing cases, and formulation of safety questions related to individual reactor types. All the functions of information retrieval have been tested carefully over several months. Particularities of project development and of the methods elaborated are described in detail. (auth)

**30325** (MRR-147) PRESSURE WAVE EXCITATION BY THERMAL INTERACTION BETWEEN MOLTEN FUELS AND WATER (MOLTEN FUEL-COOLANT INTERACTION). Teschendorff, V. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). May 1975. 72p. (In German). Dep. NTIS (US Sales Only) $6.75.

Molten Fuel Coolant Interaction (MFCI) may cause sudden pressure built up by rapid heat transfer. The computer programme BLAFCI which was created by incorporating the MFCI-model into the hydrodynamic code BLAST-2 can calculate the formation and propagation of these pressure waves. This ability is demonstrated by calculating with this combined version a number of pressure peaks measured in SPERT experiments. 23 references. (auth)

**30326** (MRR-149) NONSTEADY PRESSURE, PRESSURE DIFFERENCE, AND TEMPERATURE PATTERN IN MULTIPLY PARTITIONED FULL PRESSURE VESSELS. Comparison Between Theory and RS 50: Experiment C 1. Mansfeld, G. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). May 1975. 62p. (In German). Dep. NTIS (US Sales Only) $6.25.

The time dependent short-term pressure, temperature and pressure difference-time histories following a loss-of-coolant accident at the primary system in full pressure containments of water cooled nuclear power reactors are treated. Therefore pressure, temperature and pressure difference-time histories calculated by the mathematical model and computer code ZOCO VI have been compared with the experiment C1 of the German research program RS 50 "Druckverteilung im Containment." This comparison showed a partly good agreement between theory and experiment and gave a first insight into the simulation of the physical phenomena occuring during this short-term behaviour. 15 references. (auth)

**30327** (NEDO-21062) COMPARISON OF SAFETY-RELIEF VALVE MODEL PREDICTIONS WITH TEST DATA. Valandani, P.; Halligan, D. P. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Jul 1975. 55p. General Electric Co., San Jose, CA.

The analytical models developed at General Electric Company to describe the phenomena associated with safety-relief valve actuation are applied to large-scale and small-scale tests for model verification. The predictions of each model are compared with the available data to show that the particular phenomenon is accurately described by the corresponding model. It is shown that analytical predictions of pressures are generally conservative and phenomenologically correct. (auth)

**30328** (NP-20531) B-W OPERATING EXPERIENCE OF REACTOR INTERNALS VENT VALVES. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Dept.). [nd]. 25p. Babcock and Wilcox, Lynchburg, VA.

The purpose of this report is to provide evidence accumulated on B and W plants in commercial operation demonstrating that the vent valves remain closed during all reactor coolant system operations. The operating information presented consists of the following: (1) Oconee inspection results obtained during hot functional testing and during the recent refueling outage demonstrating continued freedom of valve operation. (2) Internals vent valve thermocouple data from Rancho Seco indicating that vent valve leakage was not a problem and that the valves remained closed over a range of power levels. (3) Loose parts monitoring (noise and vibration analysis) system results, also from Rancho Seco, indicating that no noises which are detected could be attributed to vent valve vibration or impacts on either the vent valve seats or the reactor vessel shell. A brief description of the sensitivity of this system is provided to demonstrate that had valve activity been present, it would have been detected. (auth)

**30329** (NUREG-75/072) PROCEDURES FOR EVALUATION OF VIBRATORY GROUND MOTIONS OF SOIL DEPOSITS AT NUCLEAR POWER PLANT SITES. (Shannon and Wilson, Inc., Seattle, Wash. (USA); Agbabian Associates, El Segundo, Calif. (USA)). Jun 1975. Contract AT(04-3)-954. 197p. NTIS $7.25.

According to USNRC requirements set forth in Appendix A, 10 CFR, Part 100, vibratory ground motion criteria for a nuclear plant must be based on local soil conditions, as well as on the seismicity, geology, and tectonics of the region. This report describes how such criteria can be developed by applying the latest technology associated with analytical predictions of site-dependent ground motions and with the use of composite spectra obtained from the current library of strong motion records. Recommended procedures for defining vibratory ground motion criteria contain the following steps: (1) geologic and seismologic studies; (2) site soils investigations; (3) site response sensitivity studies; (4) evaluation of local site response characteristics; (5) selection of site-matched records; and (6) appraisal and selection of seismic input criteria. An in-depth discussion of the engineering characteristics of earthquake ground motions including parameters used to characterize earthquakes and strong motion records, geologic factors that influence ground shaking, the current strong motion data base, and case histories of the effects of past earthquake events is presented. Next, geotechnical investigations of the seismologic, geologic, and site soil conditions required to develop vibratory motion criteria are briefly summarized. The current technology for establishing vibratory ground motion criteria at nuclear plant sites, including site-independent and site-dependent procedures that use data from strong motion records and from soil response analyses is described. (auth)

**30330** (ORNL-TM-4806) HTGR SAFETY STUDIES. Quarterly Progress Report for the Period Ending September 30, 1974 for the Gas Cooled Reactors Branch, Directorate of Licensing. Sanders, J. P. Sr. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 56p. Dep. NTIS $5.45.

Research progress on the evaluation of HTGR transient response is reported. The research included thermal analysis and code development and cooling system performance during past shutdown operation. (JWR)

**30331** (ORNL-TM-4875) WORK PLAN: TRANSIENT RELEASE FROM LMFBR FUEL. Kress, T. S.; Parker, G. W.; Fontana, M. H. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 121p. Dep. NTIS $5.45.

The proposed LMFBR Transient Release Program at ORNL is designed to investigate, by means of ex-reactor experiments and analytical modeling, the release and transport of fuel, fission products, and transuranic elements from fast reactor cores in the event of certain hypothetical accidents. It is desired to experimentally produce energy depositions that are characteristic of severe hypothetical reactor transients by the application of direct electrical current to mixed-oxide fuels under sodium. The experimental program includes tests with and without sodium, investigations of alternative methods of generating fuel and sodium aerosols, the use of $UO_2$ as a fuel simulant, additions of tracers as fission product simulants, effects of radiation, and under-water and under-sodium efforts to study the behavior of the vapor bubble itself. Analytical modeling will accompany all phases of the program, and the data will be correlated with models developed. 21 references. (auth)

**30332** (ORNL-TM-5061) HTGR SAFETY STUDIES FOR THE DIVISION OF TECHNICAL REVIEW, U. S. NUCLEAR REGULATORY COMMISSION. Monthly Progress Report. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 14p. Dep. NTIS $4.00.

Information is presented concerning thermal calculations for the Vrain reactor, HEXEREI code development, flow distribution calculations for HEXEREI, CCCM and HEATUP computer codes documentation, Vrain reactor flow redistribution following DBDA, and core exit gas mixing in the lower plenum. (6 references) (DCC)

**30333** (ORNL-TM-5085) MONTHLY PROGRESS REPORT FOR THE HTGR SAFETY STUDIES FOR THE DIVISION OF TECHNICAL REVIEW, U. S. NUCLEAR REGULATORY COMMISSION. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. 7p. Dep. NTIS $4.00.

**30334** (PRNC-185) HYDROGRAPHIC DATA REPORT: SOUTH COAST OF PUERTO RICO, 1973-1974. Wood, E. D.; Asencio, R. (Puerto Rico Nuclear Center, Mayaguez). 15 May 1975. Contract AT(40-1)-1833. 191p. Dep. NTIS $12.75.

The hydrographic data included in this report were collected as part of a site selection survey to provide basic oceanographic data to assist the Puerto Rico Water Resources Authority (PRWRA) in determining the best locations for additional electrical power generating facilities on the island, both nuclear and fossil fuel. This report includes data from two sites and an offshore transect between the sites. The Punta Verraco site, PVE, is on the west side of Guayanilla Bay and the Cabo Mala Pascua site, CMP, is located on the southeast corner of the island. Data were also collected seaward from Jobos Bay, OJB, to determine the effects of the open sea on nearshore oceanographic parameter characteristics. The two south coast sites are about 90 kilometers apart. The offshore Jobos Bay transect was made about 25 kilometers west of Cabo Mala Pascua. (auth)

**30335** (SAND-75-0288) ANALYTICAL MODEL FOR CABLE TRAY FIRES. Clarke, R. K. (Sandia Labs., Albuquerque, N. Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 23p. Dep. NTIS $4.00.

A model for cable tray fires based on buoyant plume theory is presented. Using the model in conjunction with empirical data on size of natural fires and burning rate of cellulosic materials, estimates are made of the heat flux as a function of vertical and horizontal distance from a tray fire. Both local fires and fires extending along a significant length of tray are considered. For the particular set of fire parameters assumed in the calculations, the current tray separation criteria of five feet vertical and three feet horizontal are found to be marginal for local fires and too small to prevent fire spread for extended tray fires. 8 references. (auth)

**30336** (UCLA-ENG-7468) TRANSIENT ANALYSIS OF LMFBR OXIDE FUEL ELEMENTS DURING ACCIDENTS. 2. Technical Report. Final Report, 1 July 1973–30 June 1974. Kastenberg, W. E. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Jul 1973. Contract AT(04-3)-34. 144p. Dep. NTIS $10.25.

A major portion of the research and development program for Liquid Metal Fast Breeder Reactors (LMFBR's) is devoted to the behavior of oxide fuel elements. Of particular interest to safety analysis and licensing is the study of transient behavior of these fuel elements under accident conditions. Work performed at UCLA during the 1973/74 academic year on this subject is described. The work reported centers on (1) understanding the possible location, time, and mode of failure for LMFBR oxide fuel pins during an overpower transient and (2) understanding the implications of this failure on the course of an unprotected overpower transient accident. The latter involves an attempt at understanding and modeling fuel dynamics internal to the pin, fuel/coolant interactions, fuel sweeping outside the pin and reactivity effects. (auth)

**30337** (UCLA-ENG-7518) POST ACCIDENT HEAT REMOVAL WITH ADVANCED LMFBR FUELS. Gasser, R. D. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Mar 1975. Contract AT(04-3) PA 222 and 223-1. 115p. Univ. of California, Los Angeles.

An analysis is performed to study the problems associated with retaining and cooling the debris subsequent to a postulated LMFBR core disassembly and meltdown accident, with emphasis placed on advanced reactor fuels such as the carbides and nitrides of uranium and plutonium. A heat transfer model for the fluidized particle bed is constructed, and a solution generated to obtain maximum bed depth at which incipient sodium boiling occurs. Experimental data for a dryout in a fluidized particle bed with volumetric heating is analyzed and corrections made to adjust for sodium as a working fluid and for the effective density of the particulate. Finally, a convective heat transfer correlation for a molten layer is used to determine the layer thickness for which incipient sodium boiling occurs at the lower surface of a "core catcher." 41 references. (auth)

**30338** (UCLA-ENG-7545) SAFETY RESEARCH NEEDS FOR CARBIDE AND NITRIDE FUELED LMFBR's. Final Report. Kastenberg, W. W. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). 15 Jun 1975. Contract AT(04-3)-34. 71p. Dep. NTIS $6.75.

The results of a study initiated at UCLA during the academic year 1974–1975 to evaluate and review the potential safety related research needs for carbide and nitride fueled LMFBR's are presented. The tasks included the following: (1) Review Core and primary system designs for any significant differences from oxide fueled reactors, (2) Review carbide (and nitride) fuel element irradiation behavior, (3) Review reactor behavior in postulated accidents, (4) Examine analytical methods of accident analysis to identify major gaps in models and data, and (5) Examine post accident heat removal. (TSS)

**30339** (UNI-449) ION EXCHANGE SYSTEM CONCEPTUAL DESIGN REPORT. Project H-501, N Reactor Supplemental Irradiated Fuel Storage, 105-KE. Etheridge, E. L. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 29 Sep 1975. 15p. Dep. NTIS $4.00.

An ion exchange system is proposed for installation to control the soluble radioisotope concentration in the 105-KE fuel storage basin water and prevent a radiation exposure problem. The system will consist of a single mixed resin bed unit mounted in an excess BDF fuel cask railcar. Mobility of the system will permit use in 105-KW fuel storage basin when that facility is reactivated for supplemental N fuel storage. (auth)

**30340** (WANL-TNR-099(Rev.B)) SAFETY REPORT FOR THE WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY (PAX AND FCX). (Naval Civil Engineering Lab., Port Hueneme, Calif. (USA)). [nd]. 24p. Dep. NTIS $4.25.

Declassified 11 Jul 1975.

Revised replacement and additional sheets are provided for the Safety Report. Besides defining management responsibility, the report deals with precautions for: Manual reactivity changes to a shutdown reactor, reactor assembly and initial criticality (poison wire removal in increments and count rate data after each incremental change), hydrogenous materials (pump oil, lubricating oil), and neutron reflection (this includes reflection by people near the reactor: Full body contact with the end of the core is prohibited and no more than three persons are allowed on the test stand in the immediate vicinity). Additional precautions are given. (LTN)

**30341** (WCAP-7153-A) INVESTIGATION OF CHEMICAL ADDITIVES FOR REACTOR CONTAINMENT SPRAYS. Bell, M. J.; Bulkowski, J. E.; Picone, L. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Apr 1975. 80p. Westinghouse Electric Corp., Pittsburgh, PA.

A study has been conducted to evaluate certain chemical additives for use in a reactor containment spray to enhance the removal of fission product iodine. Sodium thiosulfate in boric acid solution, sodium thiosulfate in alkaline boric acid solution, and alkaline boric acid solution alone were each evaluated. Laboratory tests consisted of thermal stability studies of the conditions following a hypothetical loss of coolant accident, studies of radiation stability and radiolysis of the aqueous solutions, chemical reactions between the additives and iodine, and evaluations of the corrosiveness of the spray additive solution toward plant materials.

Results of this testing and associated studies related to the reactor containment indicate alkaline boric acid solution to be superior to sodium thiosulfate solutions owing to questions of the latter's chemical/thermal stability, possible solids formation in large quantity, radiation stability, and effects it may have on solution radiolysis. (auth)

**30342** (WCAP-8172-A) PIPE BREAKS FOR THE LOCA ANALYSIS OF THE WESTINGHOUSE PRIMARY COOLANT LOOP. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Jan 1975. 152p. Westinghouse Electric Corp., Pittsburgh.

Information is presented concerning PWR primary coolant loop specifications, service experience with piping systems, stress and fatigue analyses, derivation of break locations and types, and comparison between ANS and AEC draft criteria on discrete break locations. (DCC)

**30343** (WCAP-8312-A(Rev. 2)) WESTINGHOUSE MASS AND ENERGY RELEASE FOR CONTAINMENT DESIGN. Topical Report. Shepard, R. M.; Massie, H. W. Jr.; Mark, R. H.; Docherty, P. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). Aug 1975. vp. Westinghouse Electric Corp., Pittsburgh, PA.

Methods for calculating the release of mass and energy to the containment under the assumption of a primary pipe break are presented. The methods as presented are intended for use when determining maximum containment pressures following a loss of coolant accident. (auth)

**30344** (WCAP-8568) IMPROVED THERMAL DESIGN PROCEDURE. Chelemer, H.; Boman, L. H.; Sharp, D. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Jul 1975. 94p. Westinghouse Electric Corp., Pittsburgh, PA.

A procedure is developed which satisfies the design basis that protects against departure from nucleate boiling (DNB) in a PWR core. Variations in plant operating parameters, nuclear and thermal parameters, and fuel fabrication parameters are considered statistically to obtain a DNB uncertainty factor. Applying this factor leads to a limiting DNBR value to be used for accident analysis in conjunction with input parameters at their nominal or best estimate values. The mathematical relationships are derived and a sample calculation is presented using numerical values for a 4 loop plant with $17 \times 17$ rod array fuel assemblies. The method for application of reactor protection is described and an example is given. The DNB design basis is justified by consideration of conservatism in the methods, the low probability of an overpower or overtemperature event, and the high probability that DNB will not occur. The thermal design procedure has the capability of readily and realistically accommodating additional parameters which affect DNB or changes in the value or uncertainty of parameters. (auth)

**30345** (WCAP-8583) PWR FLECHT-SET PHASE B1 EVALUATION REPORT. Waring, J. P.; Hochreiter, L. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Aug 1975. Contract E(11-1)-2279. 305p. Dep. NTIS $7.60.

The objective of the FLECHT-SET PHASE B tests was to provide experimental data describing the influence of system effects on emergency core cooling behavior during a loss-of-coolant accident. The tests were performed in a scaled facility which included a full-length, 100-rod, FLECHT-type bundle, two full-length loops with active steam generator simulators and proper flow resistances, and a full-length downcomer. The test conditions, made typical of a PWR during reflood, were varied parametrically to obtain system effects. The Phase B test results are consistent with those previously obtained in the FLECHT-SET PHASE A test series, and they provide greater simulation of a PWR. The results of the Phase B program are useful for the verification and improvement of analytical models of PWR reflooding behavior. (auth)

**30346** (XN-75-4(Vol.2)(App.C)) EXXON NUCLEAR COMPANY WREM-BASED GENERIC PWR ECCS EVALUATION MODEL. Appendix C to Volume II. Yankee Rowe Example Problem. (Exxon Nuclear Co., Richland, Wash. (USA)). 22 Aug 1975. vp. Exxon Nuclear Co., Inc., Richland, WA.

Core 12, of the Yankee Rowe (YR), plant is to be licensed with the Exxon Nuclear Co. PWR Evaluation Model. This appendix presents methodology and results of an example calculation for the YR plant using the ENC Evaluation Model. This example problem is for the double-ended guillotine cold leg break with a discharge coefficient of 0.6 assuming loss of one emergency diesel. The NSSS supplier has determined this case to give the highest peak cladding temperature (PCT) for Core 11. The YR example problem was performed to determine the maximum acceptable local peak heating rate (Kw/ft). The blowdown was performed with beginning-of-cycle (BOC) ENC fuel at full power with the hot assembly power corresponding to the design peak rod heating rate of 12.9 Kw/ft. The HOT CHANNEL, TOODEE2, and RELAP4-FLOOD runs were made at several reduced hot assembly radial peaks, holding axial peaking constant, until an acceptable PCT was achieved. This procedure results in a PCT of 1834°F at a reduced peak linear heating rate of 10.5 Kw/ft for the ENC fuel at BOC. (auth)

**30347** SAFETY ASPECT IN THE EVALUATION OF SITES FOR NUCLEAR POWER PLANTS. Gerdingh Landin, R. F. (Instituto Nacional de Energia Nuclear, Mexico City). Rev. Mex. Fis., Supl. Fis. Apl.; 23: FA105-FA120(1974). (In Spanish).

Safety evaluations of sites for nuclear power plants require that certain legal steps be taken and studies performed on several subjects. This article shows the legal bases on which the Instituto Nacional de Energia Nuclear is presently working as well as the methods that could be used to know the fission and decay products inventory, the amount of these that escape to the outside environment after passing through the engineering safety features, the concentration along the dispersion cloud and the doses to an individual exposed to the cloud. With this data it is possible to estimate the radiation risks associated with a nuclear power plant during normal and abnormal conditions. A distinction is made between the Design Basis Accident condition, of a very low probability of occurrence, and the normal operation condition. (21 references.) (auth)

**30348** HUMAN AND ECOLOGIC EFFECTS OF NUCLEAR POWER PLANTS. Sagan, L. A. (ed.). Springfield, IL; Charles C. Thomas (1974). 448p. $34.50.

An exposition is presented of the human and ecological effects of nuclear power plants, with emphasis on sources and quantities of radioactivity that enter the environment. Subject areas include the generation and management of radioactivity and the ecological effects of nuclear power generation. Specific topics cover reactor design, standards for radioactive emissions, siting criteria, waste control, accidental releases, shipment of radioactive materials, fuel reprocessing, high level waste, breeder reactors, effects of radioactive emissions from nuclear power plants, effects of thermal discharges, human radiation exposure, genetic damage, and long-lived isotopes. (Pollut. Abstr.)

**30349** CHEMISTRY IN POWER PLANTS. Hoehenberger, L. Tech. Ueberwach.; 16: No. 4, 101-103(Apr 1975). (In German).

From VGB conference on chemistry in the power plant 1974: VGB feed water conference 1974; Essen, F. R. Germany (29 Oct 1974).

On the 29th and 30th of October, 1974, the Technische Vereinigung der Grosskraftwerks-Betreiber e.V. (VGB) held its VGB conference "Chemistry in Power Plants 1974" - VGB feedwater conference 1974 - and informative exhibition in the Gruga hall in Essen. At this meeting, 11 reports were held in 2 days on the following issues: cooling water problems, measuring technique, chemistry in nuclear power plants, exhaust gas problems, and water reprocessing. (GE)

**30350** IDENTIFICATION AND EVALUATION OF HAZARDS FROM INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES. Kantor, F.; Nischan, W. F.; Murphy, K. G.; Grimes, B. K. (Nuclear Regulatory Commission, Washington, DC). J. Environ. Sci.; 18: No. 4, 16-25(1975).

From conference on energy and the environment; Anaheim, California (Apr 1975).

The U. S. Nuclear Regulatory Commission considers the threat of external hazards to proposed sites for nuclear power plants. Hazards due to industrial, transportation, and military facilities and activities in the vicinity of a proposed site are evaluated in the course of a review of an application to construct a nuclear power plant. Commission guidance on the subject of external hazards is summarized and typical hazards and the methodology employed by the Regulatory staff in the review process are discussed. (auth)

**30351** UNEASINESS ABOUT WYHL. Frey, P. Umwelt; No. 2, 15-17(Apr 1975). (In German).

Wyhl in South Baden is being considered as a site for a 1,300 MW nuclear power station by the Baden-Wuerttemberg government who is now facing serious problems. The occupation of the building site and the present delay in preparation work have accentuated a major pending problem which can no longer be side-stepped by the responsible parties: public approval of nuclear energy. (auth)

**30352** GUIDELINES FOR THE LAYOUT OF PRESTRESSED CONCRETE COMPONENTS OF NUCLEAR POWER PLANTS FOR EXTRAORDINARY EXTERNAL IMPACTS (EARTHQUAKES, EXTERNAL EXPLOSIONS, AIRCRAFT CRASH). Text of July 1974. Mitt. Inst. Bautech.; 5: No. 6, 174-181(Dec 1974). (In German).

The guidelines contain basic data to determine section quantities and the layout, as well as construction specifications, for steel reinforced concrete components which can be exposed to external impacts. They are valid for the buildings and components which do not have to fulfill any sealing functions after the occurence of the external impact. (GE)

**30353** RELIABILITY ANALYSIS OF ENGINEERED SAFETY FEATURES OF UNIT A OF THE BIBLIS NUCLEAR POWER STATION. Dressler, E.; Hoertner, H.; Nieckau, E.; Spindler, H. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). Kerntechnik; 17: No. 4, 160-167(Apr 1975). (In German and English).

The reliability analysis described deals with the engineered safety features installed to cope with the design basis accident "Large LOCA". The analysis, carried out by the fault tree method, covers the mechanical systems and their respective control systems and electric power supply. Special results of parameter studies for the different operation phases are discussed. (auth)

**30354** SAFETY EVALUATION OF THE EMERGENCY CORE COOLING SYSTEM OF THE NUCLEAR POWER STATION BIBLIS, UNIT A. Gasteiger, H.; Goedel, W. (Technischer Ueberwachungs-Verein Bayern e.V., Muenchen (F. R. Germany). Fachbereich Kerntechnik und Strahlenschutz); Karwat, H. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Feaktorregelung und Anlagensicherung). Kerntechnik; 17: No. 4, 178-181(Apr 1975). (In German).

The analyses on the emergency core cooling are of great importance to the licensing procedure of nuclear power stations. The safety evaluations on the efficiency, design, redundancy and reliability of the emergency core cooling system of the nuclear power station Biblis, Unit A, are outlined. The most important results are presented. (auth)

**30355** COMPARISON OF THEORETICAL AND EXPERIMENTAL RESULTS OF SWR EMERGENCY COOLING TESTS. Karwat, H.; Steinhoff, F. (Technische Univ. Muenchen, Garching (F. R. Germany). Reaktorstation). Atomwirtsch., Atomtech.; 20: No. 5, 238-241(May 1975). (In German).

For the purposes of the German emergency cooling program, KWU carried out SWR blowdown experiments with a four-rod element. The first results were checked by BRUCH-S-E1, a modification of the blowdown code BRUCH-S. A crack in a bursting disc is given as an example for this calculation. A good correspondence between the theoretical and the experimental pressure diagrams is achieved by correcting the critical outflow rate—calculated by Moody's model—with the help of $C_D$ factors. There are great differences between the theoretical and experimental mass flow rates, whereas the correspondence between heat transfer coefficients and temperatures in the hot spot region of the heating conductors was found to be good. (GE)

**30356** BILL RELATING TO THE PARIS AND BRUSSELS ATOMIC LIABILITY CONVENTIONS AND THIRD AMENDMENT TO THE ATOMIC ENERGY ACT. Umwelt (Inf. Bundesminist. Innern); No. 39, 3-5(Mar 1975). (In German).

Fundamental statements are presented of the Parliamentary Secretary of State in the Federal Ministry of the Interior, Baum, made in the Federal Council on February 12, 1975, during the deliberation of the proposed governmental bills on Atomic Liability with regard to the liability of DM 1,000 millon per nuclear facility for major and secondary damage (operator liability DM 500 million). (GE)

**30357** OCCUPATIONAL RADIATION EXPOSURE AT NUCLEAR POWER PLANTS. Nucl. Saf.; 16: No. 5, 614-618(1975).

A summarization is presented of the results of an investigation of occupational radiation exposures at nuclear power plants carried out by SAI Services for the Atomic Industrial Forum. Occupational radiation exposures and their sources were investigated at eight boiling-water reactors (BWRs) and at six pressurized-water reactors (PWRs) from 1969 to 1973. Activation products rather than fission products were found to be the major sources of radiation exposure to in-plant personnel for both types of reactors. The single most important nuclide contributing to exposures at BWRs was $^{60}Co$. No single nuclide was found to be dominant in PWR exposures, but steam-generator work was the largest source of exposure. The annual exposure rate was found to increase with plant age on BWRs, but there is no consistent pattern for exposure rate change with plant age on PWRs. (auth)

**30358** RECENT OCCURRENCES AT NUCLEAR REACTORS AND THEIR CAUSES. Scott, R. L. (comp.). Nucl. Saf.; 16: No. 5, 619-625(1975).

The safety-related occurrences on which reports were received at the Nuclear Safety Information Center during May and June 1975 are listed. The occurrences listed are only those at operating research reactors and at power reactors that are in commercial operation. (HDR)

**30359** SELECTED SAFETY-RELATED OCCURRENCES REPORTED IN MAY AND JUNE 1975. Casto, W. R. (comp.). Nucl. Saf.; 16: No. 5, 626-627(1975).

A reactor coolant pump seal failure at H. B. Robinson 2 and a fuel failure and off-gas release at Quad Cities 2 are discussed. (auth)

**30360** NUCLEAR SAFETY DESIGN OF THE CLINCH RIVER BREEDER REACTOR PLANT. Graham, J. Nucl. Saf.; 16: No. 5, 564-580(1975).

A description is presented of the design philosophy and safety features of the 975-MW(t) Clinch River Breeder Reactor (CRBR), a sodium-cooled demonstration reactor to be built near Oak Ridge, Tenn. The overall safety of the plant is based on three levels of protection: (1) reliable operation through intrinsic features of the design, (2) protection provided against anticipated faults and unlikely events, and (3) provision for extremely unlikely events. The principal features of each of these three safety design levels are discussed. In addition, work is continuing on a parallel design approach that treats a core-disruptive accident as a design basis. (auth)

**30361** SOLID-RADIOACTIVE-WASTE PRACTICES AT NUCLEAR POWER PLANTS. Kibbey, A. H.; Godbee, H. W. (Holifield National Lab., Oak Ridge, TN). Nucl. Saf.; 16: No. 5, 581-592(1975).

Examination of solid-radioactive-waste practices at nuclear power plants through 1972 shows that boiling-water reactors (BWRs) cumulatively generated over twice as much waste as pressurized-water reactors (PWRs) ($3.3 \times 10^5$ vs. $1.4 \times 10^5$ $ft^3$) and produced about the same cumulative thermal output [$2.2 \times 10^8$ vs. $2.5 \times 10^8$ MWh(t)]. The cumulative undecayed contents of these wastes were $6.7 \times 10^3$ and $7.7 \times 10^3$ Ci for BWRs and PWRs, respectively. Generally, PWRs incorporated all wet process wastes except spent bead resins in cement, whereas several BWRs tended to dewater sludges and resins and to sorb evaporator concentrates on high-surface-area materials without binder for shipment and burial. A recent trend for BWRs is to incorporate waste in solid matrices. (auth)

**30362** POTENTIAL EFFECTS AND CONSEQUENCES OF POSTULATED NEUTRONIC ACCIDENTS IN HTGRs. Tobias, M. (City Coll., New York). Nucl. Saf.; 16: No. 5, 546-557(1975).

Studies of postulated neutronic events of major concern in high-temperature gas-cooled reactors (HTGRs) are reviewed. The literature covered includes licensing reviews, safety-analysis reports, and topical reports prepared during the design and development of the major reactors of the General Atomic Company. Incidents considered are loss of fission products, core compression due to earthquake, fuel insertion during reloading, and steam introduction into the core, all of which are judged to be of less importance than the withdrawal of a single rod pair. Incidents such as multiple-rod withdrawal or rod ejection have been dismissed as physically impossible. Analyses of reactivity changes following a loss-of-coolant accident indicate that HTGRs will remain subcritical. Other items that continue to receive attention are the reactivity consequences of core-support collapse resulting from weakening by seismic events or steam corrosion. The physics calculations have been extensively compared with experimental results in critical facilities and operating reactors. Designers have customarily dealt with differences between observation and calculation by use of pessimistic assumptions and by continual attempts to improve theoretical approaches. Independent checking is currently sponsored by the Nuclear Regulatory Commission's Office of Nuclear Regulatory Research. (auth)

**30363** NUCLEAR LIABILITY INSURANCE: A RESUME OF RECENT YEARS. Marrone, J. Nucl. Saf.; 16: No. 5, 537-541(1975).

The nuclear liability-insurance pools have steadily increased nuclear liability insurance available to the nuclear industry to its present $125 million, which is more than double the $60 million first provided in 1957. The insurance pools also provide an additional $175 million of all-risk property insurance to protect against loss of property at a nuclear facility, for a total of $300 million. This amount of liability and property insurance available for nuclear risks exceeds the coverage the insurance industry has at risk anywhere on a single unit of risk, thus attesting to the confidence in nuclear safety. The extraordinary safety achieved and recorded by the loss experience of the nuclear pools is described. The insurance pools have proposed a change

in the Price–Anderson Act which would provide substantial additional sums of nuclear liability insurance to protect the public and which is likely to be the subject of examination by Congress during 1975. The proposal, if implemented, will gradually increase the protection afforded to the public and virtually eliminate the role of government indemnity. (auth)

**30364** PEACEFUL USE OF NUCLEAR ENERGY IN THE FRG. Appelation. Bundesrat–Drucksache; 7: No. 3410, 1-6 (Mar 1975). (In German).

Questions of some members of the Bundestag on the issues "nuclear power stations", "environmental protection", and "safety" are presented. (GE)

**30365** METHOD OF REDUCING THE CONCENTRATION OF RADIOACTIVE GAS IN A NUCLEAR REACTOR COOLANT. Marchese, R. T. (to Westinghouse Electric Corp.). German (FRG) Patent 2,429,761/A/. 6 Feb 1975. 13p. (In German).

A method of reducing the concentration of radioactive gas in the reactor cooling system is described. The concentration is increased by injection of a stable gas of the same atomic number, and the resulting mixture of radioactive and stable gas is then discharged from the flash evaporator. (GE)

**30366** NUCLEAR REACTOR WITH A UNIVERSAL SHIELDING SYSTEM. (to Nuclear Services Corp.). German(FRG) Patent 2,340,971/A/. 20 Mar 1975. 31p. (In German).

Instead of the usual manner of construction used in nuclear reactors with primary and secondary shielding of the reactor core by very thick walls of reinforced concrete, a construction is proposed using a system of double-walled steel containers which are filled with water for radiation shielding. The substructure is of a hull type and, in an empty state, enables an easy transport to water. By fixing in a water tank, the carrying water acts as a seismic shock absorber in case of an earthquake and thus protects the reactor system within the casing. The water in the single shielding containers can be used as a source for emergency water supply and for flooding the pressure vessel or core in case of an accident. (GE)

**30367** NUCLEAR POWER AND THE ENVIRONMENT. Kellermann, O. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). Atomwirtsch., Atomtech.; 20: No. 6, 304-311(Jun 1975). (In German).

From reactor conference; Nuernberg, F. R. Germany (8 Apr 1975).

When considering the environmental impact of nuclear power it is necessary to regard nuclear power in relation to the other sources of primary energy. In a comparison of the problems affecting all sources of energy in the same or a modified way and of the specific problems attached to the individual sources of energy, nuclear power comes out quite well. The generation of secondary energy by means of nuclear fission gives rise to a lower environmental burden than does generation by fossil fired power stations. However, the growth rate of electricity generation as a whole should be slowed down and the use of waste heat should be improved. The problem of heat losses is the key problem in environmental pollution in the decades to come. Nuclear power is very flexible in terms of siting. The emission of pollutants from nuclear power stations is much less severe than it is in comparable branches of industry. More attention must be devoted to the reduction of the radiation exposure of the personnel employed in nuclear plants by improving the conditions of maintenance and repair. Problems arising in connection with decommissioning should also be included in future planning. (auth)

**30368** MEASUREMENT OF VAPOR PRESSURE OF $(U,Pu)O_2$ AND $UO_2$ TO 5000°K FOR FAST REACTOR SAFETY ANALYSIS AND THE CONTRIBUTION OF THE RADIAL Cs DISTRIBUTION TO FUEL PIN FAILURE. Ohse, R. W. (European Inst. for Transuranium Elements, Karlsruhe, Ger.); Berrie, P. G.; Bogensberger, H. G.; Fischer, E. A. pp 307-325 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

The analysis of hypothetical accidents of fast breeder reactors requires vapor pressure data extending to 5000°K. So far measurements have only been made up to 3000°K, these being extrapolated to the higher temperature. Such data did not take into account the influence of highly volatile fission products. In the work presented here, a new high-energy laser technique, including fast temperature recording in the microsecond range, was developed for measuring the vapor pressure of fast breeder uranium–plutonium oxide fuels up to 7000°K. In the ternary system, the pressure of uranium–plutonium oxide above its melting point was determined to be log p(atm) = 7.966 – (28137/T), yielding a high-temperature heat of evaporation of $\Delta H_{evap}$ = 128.7 kcal/mol. Measurement of the $UO_2$ partial pressure over the solid gave log p(atm) = 9.365 – (32436/T), resulting in a heat of sublimation of $\Delta H_{sub}$ = 148.4 kcal/mol. The difference of these heats yields the heat of fusion $\Delta H_f$ = 19.7 kcal/mol, which is in good agreement with the literature value of 19.4 kcal/mol. In the binary $UO_2$ system, the pressure above the melting point was determined to be log p(atm) = 7.7 – (27900/T), giving a heat of evaporation of $\Delta H_{evap}$ = 127.6 kcal/mol. An assessment of literature data for below the melting point yielded log p(atm) = 8.846 – (31506/T), and a heat of sublimation of $\Delta H_{sub}$ = 144.1 kcal/mol. The resulting heat of fusion, $\Delta H_f$ = 16.5 kcal/mol, is slightly below the published value of $\Delta H_f$ = 17.7 kcal/mol. In addition to the pressure of pure fuel, safety analysis requires knowledge of the transient behavior of the volatile fission products. Details of studies on cesium radial distribution are also given, to complement previous work on krypton and xenon. The calculated cesium release is shown to lead to a significant contribution to the transient pressure, demonstrating the necessity of including such data in accident analysis. (auth)

**30369** OUT-OF-PILE MELTING OF URANIUM OXIDE. Amblard, M. (CEN, Grenoble, France). pp 341-353 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975). (In French)

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

In the context of safety studies on fast reactors, the problem of the interaction between the melted fuel and the coolant has led to the development of several experimental devices by means of which a variable mass of uranium oxide can be melted and brought into contact with liquid sodium in various configurations. The following experiments were performed: dropping a few grams of $UO_2$ into a small volume of sodium; projection of a few grams of $UO_2$, melted under high pressure, against metal assemblies; melting a 7 g rod of $UO_2$ by the Joule effect, enabling the interaction of sodium to be studied under load (Jef experiment); injection of a small mass of sodium into 7 kg of $UO_2$ melted by high frequency (Corect I); interaction under load of 7 kg of liquid $UO_2$ with 100 l of sodium (Corect II). An experiment based on dropping a mass of $UO_2$ into an infinite pool of sodium (Corect III) is planned. (auth)

**30370** INVESTIGATIONS OF MOLTEN "CORIUM" PHASES. Peehs, M. (Kraftwerk Union AG, Erlangen, Ger.). pp 355-368 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

Characteristic compositions of molten phases after a hypothetical core-melting accident for an LWR was defined for the beginning and the end of ultimate melting for core materials and materials contained in the pressure vessel designated "Corium A" and "Corium E" respectively. The experiments to investigate the metallurgical behavior of such material compositions have been done under isothermal and inert-gas conditions. C/ZrC and TaC crucibles were used. The temperature of complete liquefaction of "Corium" is 2400°C, due to a $Zr/UO_2$ reaction. The liquidus temperature of a formalized "Corium" is about 1950°C. The solidus temperature depends on the iron content of the melt and, under realistic conditions, is in the range of 1080°C. (auth)

**30371** DEVELOPMENT OF ENVIRONMENT-ORIENTED TECHNICAL REGULATIONS FOR NUCLEAR FACILITIES: RECENT EXPERIENCE. Firth, R. W. Jr.; Glynn, R. D. Jr. Arch. Energiewirtsch.; 29: No. 5, 458-460(May 1975). (In German).

The development of regulations for the protection of the public in the construction of nuclear facilities is described. These regulations guarantee that a nuclear facility works within clearly defined boundaries and that the environmental impact of its operation is kept as low as possible for purposes of environmental protection. (GE)

**30372** RELIABILITY OF NUCLEAR POWER PLANTS. Haueter, R. L. (Consumers Power Co., Jackson, Mich. (USA)). Arch. Energiewirtsch.; 29: No. 5, 456-458(May 1975). (In German).

A program for the collection of reliability data and statistical data on reactor components which has been established by the member firms of the Edison Electric Institute is described. (GE)

**30373** AUSLEGUNG VON KERNKRAFTWERKEN GEGEN SEISMISCHE EINWIRKUNGEN. I. Grundsaetze. Entwurf 9/74. (Design of Nuclear Power Plants Against Seismic Effects. I. Fundamentals. Draft 9/74). Cologne; Heymanns (1974). 5p.

The draft standard applies to all stationary nuclear power facilities in the FRG. It contains fundamental remarks on design basis and safety earthquakes, earthquake zones and seismophysical reference values, classification of structural components, load specifications and combinations, dynamic and simplified seismic calculations, stresses and deformation, seismic instrumentation, effects of the safety earthquake on the reactor site and its surroundings. (GE)

**30374** RADIOLOGICAL ASSESSMENT OF NUCLEAR POWER STATIONS. Kaye, S. V.; Rohwer, P. S. (Oak Ridge National Lab., TN). Adv. Radiat. Biol.; 5: 47-81(1975).

Experience has shown that nuclear power reactors are safe, clean, and reliable sources of electrical energy, but because of the enormous quantities of radionuclides produced in reactors, they are potentially dangerous to public health if any significant quantity were to escape to the environment. All systems constituting a nuclear power reactor are designed to mitigate the loss of radioactivity from the reactor containments. The small quantities which are discharged to the atmosphere or to bodies of natural waters are discharged in a controlled manner. Subsequent environmental transport pathways and exposure of individuals and populations are discussed. Data needed and the methods employed to calculate relevant radiation doses for planned or operating nuclear power plants are included. (50 references) (CH)

**30375** EQUATION OF STATE FOR SODIUM OVER AN EXTENDED TEMPERATURE AND DENSITY RANGE. Barnes, J. F. (Los Alamos Scientific Lab., NM). pp 327-339 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

Coupled neutronics and hydrodynamic calculations of hypothetical core disruptive accidents of a liquid-metal fast breeder reactor require realistic equations of state of the relevant component materials over a very large range of temperature and density. The methods used to construct a general equation of state for sodium are described that will be utilized in tabular form by a complex computer code under development at Los Alamos Scientific Laboratory for the assessment of reactor safety. The technique considers pressure to be the sum of a cold pressure determined by the cohesive energy of the solid and a thermal term that varies from resembling that in a solid at normal density to ideal gas behavior at low density. The predicted critical point data and vapor pressure as a function of temperature are in reasonable agreement with experiment and this is the basis for confidence in the general shape of the isotherms; calculated vapor pressures are then supplanted by experimental values. Tabular data are presented for densities from $10^{-5}$ to 1.2 times the normal density of the solid and for temperatures from 300 to $4000^{0}$K. (auth)

**30376** SEISMIC DESIGN OF STRUCTURES FOR NUCLEAR REACTORS. Method of Earthquake Response Analysis for Reactor Internals. Tsushima, Y.; Jido, J.; Abe, Y.; (Takenaka Komuten Co. Ltd., Tokyo). Takenaka Gijutsu Kenkyu Hokoku; No. 12, 183-210(Aug 1974).

A new method is proposed for the dynamic response analysis of light-weight structures such as fuel assemblages and shell structures including, for example, drywells, which have dynamical membranous properties, and must be computed with multi-degrees of freedom. A general description is presented of the theoretical and analytical investigation. Included are: (1) characteristics of composite structures; (2) response analysis techniques with respect to light-weight structures; (3) equations of motion and response analysis techniques; (4) examination of this method; and (5) system program and numerical examples. (auth)

**30377** VdTUeV MERKBLATT: KERNTECHNIK. Schaltung der Notstromversorgung. (VdTUeV Leaflet: Nuclear Engineering. Circuit for Emergency Power Supply). Herford, F. R. Germany; Maximilian (1974). vp.

Safety standards for the electrical equipment of nuclear power stations are presented. (GE)

**30378** VdTUeV MERKBLATT: KERNTECHNIK. Trennung des Reaktorschutzsystems von anderen Systemen der Messwertverarbeitung. (VdTUeV Leaflet: Nuclear Engineering. Separation of the Reactor Protection System From Other Data Processing Systems). Herford, F. R. Germany; Maximilian (1975). vp.

Safety standards for the layout of reactor protection systems are presented. (GE)

**30379** VdTUeV MERKBLATT: KERNTECHNIK. Pruefung am Reaktorschutzsystem. (VdTUeV Leaflet: Nuclear Engineering. Reactor Protection Systems Testing). Herford, F. R. Germany; Maximilian (1974). vp.

Safety standards for testing reactor protection systems are presented. (GE)

**30380** OPERATIONAL MEASUREMENT OF CYCLE AND EFFLUENT ACTIVITIES OF NUCLEAR FACILITIES. Beck, J.; Bauer, P. (Hartmann und Braun A. G., Muenchen (F. R. Germany)); Hofmann, W. (Kernkraftwerk Unterweser O. H. G., Esenshamm (F. R. Germany)). VGB Kraftwerkstech.; 55: No. 4, 229-234(Apr 1975). (In German).

7 figs.; 2 tabs.; 4 refs.

Control measurements are carried out in nuclear facilities to determine the specific activity of a medium. This is done in two ways. A continuous measuring system is installed to determine specific activities independently of the isotopic composition so that an increase of activity due to a reactor incident will be immediately detected. In addition to this, the isotopic composition of the mixture is controlled by periodic sampling in laboratories. (GE)

**30381** STRUCTURAL DAMAGE IN NUCLEAR POWER PLANTS. Zingler, P. (Allianz Versicherungs-A. G., Muenchen (F. R. Germany). Abt. Technische Versicherungen). Maschinenschaden; 47: No. 6, 222-239(1974). (In German).

43 figs.

Structural damage in nuclear power plants which has been reported to German builder's risk insurances is described. Exposed structural components and possible sources of trouble in power plant construction are pointed out. (GE)

**30382** THERMAL INTERACTION EXPERIMENTS WITH $UO_2$ AND SODIUM USING PYROTECHNIC HEATING. Halliwell, N. A. (UKAEA Safety and Reliability Directorate, Risley); Pottinger, R. C. (UKAEA Weapons Group, Foulness. Atomic Weapons Research Establishment). Nucl. Eng. Des.; 32: No. 3, 311-324 (1975).

An experimental technique is described which tests for the possibility of a thermal interaction between $UO_2$ and sodium. Pyrotechnic heating is used to raise the temperature of the $UO_2$ to within the range 3000–3500 K. Difficulties involved in using this type of heating are discussed and an analysis is presented which calculates the thermodynamic properties of the residues which are released into the sodium. The geometry of the apparatus is such that evidence of a thermal interaction can be provided by the measurement of the argon gas blanket pressure. For a given pyrotechnic charge releasing $UO_2$ under sodium it is shown that there is a limiting peak gas blanket pressure below which it is not possible to state that an interaction has taken place. This limiting pressure is shown to be dependent upon the type and quantity of dispersant which is used to release the charge products. In these preliminary tests no evidence could be found of any thermal interaction between $UO_2$ and sodium but a substantial series of tests is prepared in which significant parameters are varied in order to investigate under what conditions such reactions might occur. Results are also reported from preparatory tests where pyrotechnic charges diluted with silver, alumina and tin were burned under water in a glass windowed vessel. In these latter tests high speed photography allowed visual examination of the charge release. (auth)

**30383** ENVIRONMENTAL STRUCTURAL CONSIDERATIONS IN NUCLEAR FACILITY RISK ASSESSMENT. Schauer, F. P.; Shinozuka, M. (Columbia Univ., New York (USA)). Nucl. Eng. Des.; 32: No. 3, 410-420(1975).

The concept of risk as it relates to nuclear power facilities is introduced. The role of the environment and its relationship to containment design considerations are analyzed. The loads significant to the performance of a containment are selected and combined in a manner so as to represent the paths to failure. Specific probability values for these loads and related structural resistances are either selected from other studies or assumed, resulting in an evaluation of path risks. The manner is illustrated in which environmental and structural aspects of the facility can be jointly considered to reduce the risk. (auth)

**30384** AN APPROXIMATE METHOD FOR CALCULATING SECONDARY CRITICALITY FOLLOWING LMFBR MELTDOWN ACCIDENTS. Ferrell, W.; Suo-Anttila, A.; Catton, I.; Kastenberg, W. E. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Nucl. Eng. Des.; 32: No. 3, 421-427(1975).

A major concern following a meltdown accident in an LMFBR is the possibility of secondary criticality. An approximate method is presented for determining criticality as a function of pool depth, geometry and reflectivity of the surrounding material. Using this method, ramp rates are determined for the case of a subcritical pool being filled by core debris falling from above.

It is shown that in addition to the very large ramps which are normally considered, several configurations lead to much smaller ramps, which should also be considered in subsequent safety analyses. (auth)

## Reactor Theory and Calculation

**30385** (AED-CONF-73-434-001) MEASUREMENT OF THE FREQUENCY RESPONSE OF A SPLIT CORE NUCLEAR REACTOR. Hinds, H. W.; McDonnell, F. N.; Walker, D. H. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). [nd]. 16p. (CONF-731233-5). INIS.

From conference on automatic control; Fredericton, New Brunswick, Canada (24 Sep 1973).

As nuclear power plants increase in size, a tendency to instability in higher spatial modes, and in particular the first azimuthal mode, also increases. To test the accuracy of theoretical models in the first azimuthal mode, frequency response tests were conducted on a small reactor with a split core. The tests used a pseudo-random binary sequence (PRBS) as the driving function for two oppositely acting symmetrically located cadmium absorbers. The flux was measured by two symmetrically located flux detectors. By comparing the difference in absorber position with the difference in neutron fluxes a measure of the first azimuthal frequency response is obtained. Similarly by comparing their sums, the fundamental mode frequency response is obtained. Both m- and n-type PRBS were used with the latter producing better results because of its ability to discriminate against nonlinear effects. (auth)

**30386** (CONF-750935-1) REVIEW OF UNFOLDING METHODS FOR NEUTRON FLUX DOSIMETRY. Stallmann, F. W.; Kam, F. B. K. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., Tenn. (USA)). 1975. 12p. Dep. NTIS $4.00.

From 1st ASTM-Euratom symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

The primary method in reactor dosimetry is the foil activation technique. To translate the activation measurements into neutron fluxes, a special data processing technique called unfolding is needed. Some general observations about the problems and the reliability of this approach to reactor dosimetry are presented. Current unfolding methods are reviewed. 12 references. (auth)

**30387** (COO-2458-4) ANALYTICAL APPROACH TO FAST REACTOR FUEL CYCLE ANALYSIS. Sierra, J.; Becker, M. (Rensselaer Polytechnic Inst., Troy, N. Y. (USA). Dept. of Nuclear Engineering). 1975. Contract AT(11-1)-2458. 5p. (CONF-751101-4). Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The use of analytical methods and data correlations for treating fuel depletion and fuel cycle analysis in fast reactors is illustrated. (JWR)

**30388** (EURFNR-1243) MONTE CARLO CALCULATION OF QUOTIENTS IN REACTOR PHYSICS. Brandl, V. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Feb 1975. Translation of KFK-2074. 56p. Dep. NTIS $5.45.

Work performed under United States-Euratom Fast Reactor Exchange Program.

A solid theoretical basis of the Monte Carlo calculation of ratios is established. The exact distribution density of ratios is developed and discussed. In addition for the Monte Carlo practice a handy approximation formula of the distribution density and the statistical error of quotients is developed. Its quality and validity range are discussed in a parameter study. 4 references. (auth)

**30389** (INIS-mf-1733, pp 3-16) NEUTRON THERMALIZATION AND DATA PREPARATION FOR LIGHT-WATER REACTORS. Hron, M. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

A survey is presented of the physical and computational models of scattering kernels for thermal neutrons. The calculation of the neutron velocity and spatial distributions in a light-water lattice is demonstrated on the solution of the Boltzmann transport equation applying the first collision probability method. (INIS)

**30390** (INIS-mf-1733, pp 17-26) CRITICALITY CALCULATIONS OF LIGHT-WATER REACTORS. Vanicek, J. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

An iterative method of solving two-dimensional multigroup diffusion equations is proposed with the objective of ascertaining the neutron flux spatial distribution. The solution reflects satisfactorily the uneven arrangement of fuel elements, channels, and probes in the light-water reactor core and reflectors. (INIS)

**30391** (INIS-mf-1733, pp 27-39) BURNUP CALCULATION OF LIGHT-WATER REACTOR. Zalesky, K. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

Basic methods of calculating the burnup in a light-water reactor are presented. Also discussed are certain simplifying assumptions. Program PRALIN for local burnup calculations is described as an example. (INIS)

**30392** (INIS-mf-1733, pp 54-61) NOTES ON REACTOR KINETICS CALCULATIONS. Jurecka, J. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

In practical calculations of reactor kinetics the effect is discussed of the delayed neutron parameters applied. The model approximation of the spatial integration employed in the DEREX program is described as well as the application of Lagrange polynomials in the temporal integration for the solution of spatial kinetics problems. (INIS)

**30393** (INIS-mf-1733, pp 62-72) GROUP CONSTANTS FOR NUCLEAR REACTOR CALCULATIONS. Veverka, O. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

The principles are presented of group constant determination for the calculation of nuclear reactors. The problem is solved for the case of an isotropic diffusion medium assuming certain permissible simplifications. (INIS)

**30394** (INIS-mf-1733, pp 73-82) LINEAR AND BILINEAR AVERAGING OF CONSTANTS FOR FAST REACTOR CALCULATIONS. Svarny, J. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

Main approaches are described to the averaging of fast reactor constants in the stationary state, including the variational, the perturbation, and the balance methods. (INIS)

**30395** (INIS-mf-1733, pp 83-89) FUEL BURNUP CALCULATION FOR FAST REACTORS. Kujal, B. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

The method of calculating changes in the isotopic composition of the fast power reactor fuel is given and the applied simplifications are discussed. The calculation of point burnup for constant values of the cross sections and of the neutron flux in a one-group approximation is shown as an example of the analytical solution. (INIS)

**30396** (INIS-mf-1733, pp 90-93) FUEL CYCLE OF FAST POWER REACTOR. Kujal, J. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

The problems related to the fuel cycle of a fast power reactor are discussed. (INIS)

**30397** (INIS-mf-1733, pp 94-103) REACTIVITY EFFECTS IN FAST REACTORS. Tinka, I. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

Possible applications are discussed of the perturbation theory in calculating fast reactor activity. (INIS)

**30398** (INIS-mf-1733, pp 118-135) THE ROLE OF CRITICALITY EXPERIMENTS IN FAST REACTOR PHYSICS. Osmera, B. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

The physical problems are discussed of fast reactor design as is the equipment for criticality experiments. Experimental methods are described of finding the critical mass, reactivity, reactivity coefficients, reaction rate distributions, and the neutron spectra. (INIS)

**30399** (INIS-mf-1733, pp 136-147) METHODS AND PROGRAMMES OF FAST REACTOR COMPUTATIONS. Cermak, J. Sep 1972. (In Czech).

From seminar on physics calculations of light-water and fast nuclear reactors; Prague, Czechoslovakia (Feb 1972).

In seminar on physics calculations of light-water and fast nuclear reactors. Proceedings of the seminar. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska).

The applications are described of the multi-group approximation method and of the Galerkin method of solving diffusion equations in the determination of the critical reactor dimension and of the corresponding neutron flux distribution. (INIS)

**30400** (JUL-1174) APPLICATION EXAMPLES OF ADJOINT FLUX BEHAVIOUR BY MEASUREMENTS AND CALCULATIONS AT THE CRITICAL ASSEMBLIES FOR THE ITR AND FOR THE HTR. Rueckert, M. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung). Mar 1975. 85p. (In German). Dep. NTIS (US Sales Only) $7.25.

Thesis.

Some applications of adjoint calculation methods are shown for two zero power reactors with different physical properties. Measurement and calculation of adjoint fluxes are compared. Corrective factors for the local-dependent reactor kinetics are given. The perturbation calculation verifies small reactivity effects. Adjoint biasing increases the calculation economy by Monte-Carlo-methods. A comparison is obtained of the suitability of diffusion-, $S_N$- and Monte-Carlo-codes for different reactor plants. (auth)

**30401** CONVERGENCE AND STABILITY OF ROTHE'S METHOD FOR SOLVING THE NONSTATIONARY SYSTEM OF REACTOR KINETICS. Kuznetsov, Yu. A.; Morozov, S. F. Zh. Vychisl. Mat. i Mat. Fiz.; 15: No. 2, 404-411(1975). (In Russian).

The convergence of an approximate solution obtained by Rothe's method with the precise solution of a system of equations of reactor kinetics and the stability of the difference in the scheme were studied, and estimates of the error are given. 6 references. (tr-auth)

**30402** NEW METHOD FOR FAST REACTOR GROUP DIFFUSION CALCULATIONS. Hennart, J. P. (Instituto Politecnico Nacional, Mexico City). Bull. Cl. Sci., Acad. R. Belg.; 61: 140-172(Feb 1975).

A formalism utilizing variational synthesis is developed to approximate the solution of the fast reactor multigroup diffusion equations. (DG)

## Reactor Components and Accessories

*Refer also to abstracts 27846, 28496, and 30335.*

**30403** (BMI-1937) CRITICAL EXPERIMENTS, MEASUREMENTS AND ANALYSES TO ESTABLISH A CRACK ARREST METHODOLOGY FOR NUCLEAR PRESSURE VESSEL STEELS. First Annual Progress Report. Hahn, G. T.; Gehlen, P. C.; Hoagland, R. G.; Kanninen, M. F.; Popelar, C.; Rosenfield, A. R.; deCampos, V. S. (Battelle Columbus Labs., Ohio (USA)). Aug 1975. Contract W-7405-eng-92. 174p. Dep. NTIS $7.60.

The one-dimensional, Timoshenko beam-on-a-generalized elastic foundation treatment has been extended to contoured-DCB specimens and to the conditions attending tensile loading in an ordinary testing machine. Preliminary calculations show that the crack propagation and arrest events in contoured DCB specimens are very similar to those calculated for regular DCB-specimens for comparable initiation conditions. In both cases the calculated K/sub Ia/-values are between 44 percent and 100 percent of K/sub ID,min/ and show a systematic variation with the initiation K/sub Q/-level. In contrast with stiff wedge loading, which favors a continuous event, the calculations for rectangular and contoured DCB specimens in series with an idealized testing machine load train display one or more halts and restarts before the final arrest. A series of experiments designed to distinguish between the K/sub D/ and K/sub a/ approaches to predicting crack arrest are described. Studies of the effect of side grooves in rectangular DCB specimens confirm that grooves with depths representing up to 60 percent of the cross section have no significant effect on either K/sub ID/ or K/sub Ia/ measurements. (auth)

**30404** (BNWL-tr-150) FILTER PROGRAM. Wilhelm, J. G.; Deuber, H.; Dillmann, H. G.; Furrer, J.; Gerlach, K.; Kaempffer, R.; Weinert, A. (Kernforschungszentrum Karlsruhe (F. R. Germany)). 1973. Translation of Excerpt from Department Radiation Protection and Safety Yearly Report 1973. 38p. Dep. NTIS $5.00.

Air filter research and development in the following areas is discussed: post-accident recirculation filter for removal of fission products from containment atmospheres; exhaust air filters for reprocessing facilities; and exhaust air filters for reactors. (JWR)

**30405** (CONF-750935-12) FISSION-RATE MEASUREMENTS BY ACTIVATION TECHNIQUES: METHODS, ACCURACIES, AND APPLICATIONS. Dudey, N. D.; Heinrich, R. R. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-Eng-38. 23p. Dep. NTIS $4.25.

From 1st ASTM-Euratom symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

The U. S. reactor development programs have established the need for developing a capability to measure fission rates to an absolute accuracy of +-2 percent. To achieve this goal, a national program is operative to develop and apply the necessary methodology. The approach is to use gamma-active fission product monitors to define fission rates for $^{235}U$, $^{238}U$, $^{237}Np$, and $^{239}Pu$. Emphasis is upon redundant tests of the critical steps including mass assay, gamma counting, and fission yield determinations via a multiple laboratory approach. The methods are developed and tested in benchmark-type neutron fields, usually of low intensity (less than $10^{12}$ n/cm$^2$-sec) and applications of fission-rate measurements include EBR-II, fast critical assemblies, and CTR irradiation facilities. The most general approach, using conventional fission yields, is capable of +-3.5 percent accuracy, whereas under certain specific conditions, accuracies of 2-2.5 percent are possible. 20 references. (auth)

**30406** (HEDL-SA-901) NEUTRON SPECTROMETRY FOR REACTOR APPLICATIONS: STATUS, LIMITATIONS, AND FUTURE DIRECTIONS. Gold, R. (Westinghouse Hanford Co., Richland, Wash. (USA)). Aug 1975. Contract E(45-1)-2170. 33p. (CONF-750935-5). Dep. NTIS $4.75.

From 1st ASTM-Euratom symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

The ability of "state-of-the-art" reactor neutron spectrometry to provide definitive environmental results required for high fluence radiation damage experiments is reviewed. A formal definition of the neutron component is presented as well as general considerations which accrue from both this definition and the existence of the mixed radiation field generally encountered in reactors. A description of four selected methods of reactor neutron spectrometry is included, namely Proton Recoil (PR) methods, Time-Of-Flight (TOF) methods, the $^6Li$(n,alpha)$^3H$ coincidence method, and Multiple Foil Activation (MFA) methods. These selected methods are compared. Future requirements and directions for reactor neutron spectrometry are discussed. In particular, the needs of future CTR research are stressed and the $He^4$-recoil proportional counter spectroscopy method is advanced as a means of meeting these future requirements. 50 references. (auth)

**30407** (HEDL-SA-939) DOSIMETRY FOR FLUENCE APPLICATIONS. Farrar, H. IV; Lippincott, E. P.; McElroy, W. N. (Atomics International Div., Canoga Park, Calif. (USA); Hanford

Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2170. 16p. (CONF-750935-10). Dep. NTIS $4.00.

From 1st ASTM-EURATOM symposium on reactor dosimetry; developments and standardization; Petten, Netherlands (22 Sep 1975).

An extension of the multiple-foil technique is now being implemented where monitors with stable ($^{3}$He and $^{148}$Nd) and relatively long-lived ($^{60}$Co, $^{137}$Cs) products are included. Helium accumulation fluence monitors (HAFM's) which consist of miniature vanadium capsules containing various materials with different (n,alpha) cross section energy responses have been added to the foil sets. The generalized helium is measured with approximately 2 percent absolute accuracy by isotope dilution mass spectrometry. This expanded multiple-foil technique gives a direct measure of fluence-spectrum, instead of the more usual flux-spectrum. Such information is most important for accurate correlation of irradiation effects data. 54 references. (auth)

**30408** (INIS-mf-1521, pp STEV1-STEV18) WORLD SURVEY OF OPERATING EXPERIENCE WITH WATER-COOLED NUCLEAR REACTOR STEAM GENERATORS. Stevens-Guille, P. D. (Chalk River Nuclear Labs., Ont.). 1974.

From conference on heat transfer and the design and operation of heat exchangers; Johannesburg, South Africa (18 Apr 1974). (South African Inst. of Chemical Engineers, Johannesburg; South African Inst. of Mechanical Engineers, Johannesburg; Council for Scientific and Industrial Research, Pretoria (South Africa)).

In March 1971 the 100th nuclear power reactor in the world commenced operation. By the end of 1972, 1000 reactor years of operating experience had been accumulated. When South Africa builds nuclear power stations lessons learned from the operating experience can lead to substantial savings in capital and operating costs. Worldwide operating experience of water-cooled nuclear reactor steam generators to the end of 1972 is surveyed. Steam generators are critical components, vulnerable to internal leaks due to their large, thin heat transfer surfaces. Many new plants have steam generators with over 1 hectare of ~2mm heat transfer surface, comprising over 75% of the total primary system pressure retaining boundary. Of the 41 reactors with steam generators in operation prior to January 1, 1973, 19 had experienced in-service steam generator tube failures: various types of corrosion were responsible for over half of these failures. Other causes include tubesheet cladding failure, mechanical damage by debris and tube fretting by flow induced vibration. New technology aimed at improving steam generator reliability is discussed in the fields of design, manufacturing and operation. (INIS)

**30409** (MRR-148) DETERMINATION OF THE TWO-DIMENSIONAL NONLINEAR TEMPERATURE BEHAVIOR OF REACTOR COMPONENTS WITH COMPLEX GEOMETRY WITH CONSIDERATION OF INHOMOGENEITY AND ANISOTROPY. Simon-Weidner, J. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). May 1975. 110p. (In German). Dep. NTIS (US Sales Only) $8.50.

A code is described for the evaluation of two-dimensional temperature fields of reactor components of complex structure. Temperature and/or time dependent characteristics of material and of boundary conditions are considered. Solving such problems the finite element method has been chosen with the feature that systems consisting of different temperature and/or time dependent material characteristics are allowed. Various boundary conditions can be considered too, which may be different from each other or can be interconnected. A further feature of this method is the absolute stability and the ability of computation of complex structures. 46 references. (auth)

**30410** (ORNL-TM-5051) MOISTURE MIGRATION IN CONCRETE. Final Report. Technical Report C-75-1. McDonald, J. E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). May 1975. 73p. Dep. NTIS $4.00.

For Oak Ridge National Lab., TN.

In an effort to obtain information regarding the nature of moisture movement and rate of moisture loss in a prestressed concrete reactor vessel (PCRV), an experimental study of moisture migration in a pie-shaped specimen representing the flow path through a cylindrical wall of a PCRV was initiated. After casting of the test specimen, temperature distribution, shrinkage, and moisture distribution were monitored for approximately 510 days. After this initial monitoring, a temperature difference of 80°F was applied to the specimen, and the above-mentioned measurements were continued for an additional test period of one year. Results indicate that moisture migration in thick sections of concrete, such as a PCRV, is a slow process and is not likely to be a significant factor with temperature differences of 80°F or less. 15 references. (auth)

**30411** (RD/B/N-3013) DETERMINATION OF LEAKAGE FLOW REGIMES AND THE ABILITY TO APPROACH LAMINAR CONDITIONS IN LARGE PLANT. Chivers, T. C.; Hunt, R. P.; Rogers, W. J.; Williams, M. E. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Apr 1974. 46p. Dep. NTIS (US Sales Only) $5.50.

Theoretical analysis showed that, in the absence of gross surface damage, seal leakage should be non-turbulent, and this was confirmed by a large number of experimental results obtained in a laboratory. The conclusion is shown to be valid for full scale operational plant provided that large leaks are identified and repaired. The experiments were conducted on parts of the by-pass plant at Dungeness "B" A. G. R. prior to commissioning. Air, $CO_2$ and helium were used and for all three the volumetric losses were very similar. Balancing overall pressure drop measurements with the summed losses from individual seals shows diffusion through vessel walls to be insignificant. The low temperature at which these tests were conducted necessitated the development of special techniques for the correction of $CO_2$ data because of its non-ideal gas behaviour. These methods are described and the interpretation of pressure drop/time data, and the most meaningful way of presenting it, are considered. (auth)

**30412** (TNO-LMEC-6) 50 MWe TEST LOOP. Monthly Report, June 1974 (Weeks 23-26). (Nijverheidsorganisatie TNO, Apeldoorn-Zuid (Netherlands). Centraal Technisch Instituut TNO). 1974. Translation of a Dutch Report. 14p. Dep. NTIS $4.00.

Work performed under United States-TNO Technical Exchange Program.

An exceptionally large number of experiments were carried out during June 1974. Numerous tests were conducted not only on the steam generator (straight tubes), but also on the intermediate heat exchanger, the Neratoom valve and the cold trap. By the rapid correction of a number of malfunctions and on account of the faster rate at which the tests were conducted, the program was completed on June 28, when the installation was taken out of service for removal of the evaporator. (auth)

**30413** (TNO-LMEC-7) 50 MWe TEST LOOP. Monthly Report, July-August 1974 (Weeks 27-35). (Nijverheidsorganisatie TNO, Apeldoorn-Zuid (Netherlands). Centraal Technisch Instituut TNO). 1974. Translation of a Dutch Report. 29p. Dep. NTIS $4.00.

Work performed under United States-TNO Technical Exchange Program.

Up till August 12 work was carried out on the installation, which was not in operation during that time. After August 12 continuous operation was resumed again. After preoperational tests had been performed, the sodium system was filled up with sodium again on August 14. The WDE is now connected up again, while the GDE evaporator and the IHX are no longer connected up to the system. The installation was connected up thermally for the first time again on August 23, this being followed immediately by a test of ESD 105 at 50 kg/cm$^2$. The TVP was in operation with the new connection. The turbine functioned excellently, the only leak observed being one in the flanged joint, which developed after a short period in operation. Since this leak cannot be repaired during operation, the turbine was taken out of service again and the repair is to be carried out in week 38 during the next period. Since the TVP and all three furnaces were not available, the installation could not be operated under full load conditions during this period, the maximum load reached being 50 percent. For this reason no tests were carried out on the steam generator. During the next period a start is to be made on repeating the steady-state measurements. (auth)

**30414** (TNO-LMEC-8) 50 MWe TEST LOOP. Monthly Report, September 1974 (Weeks 36-39). (Nijverheidsorganisatie TNO, Apeldoorn-Zuid (Netherlands). Centraal Technisch Instituut TNO). 1974. Translation of a Dutch Report. 23p. Dep. NTIS $4.00.

Work performed under United States-TNO Technical Exchange Program.

Operation of the installation during this period was only interrupted once in week 38 as a result of shutdown work and the removal of the IHX. A number of steady-state measurements were carried out on the E 204. During this period the installation could not be run at full load owing to the non-availability of three furnaces and also, at the beginning of the period, the TVP. Tests were carried out on the MT 108 and on the furnace dump line. (auth)

**30415** TURBO-GENERATOR SETS IN CONVENTIONAL AND NUCLEAR POWER STATIONS. Bald, A. (Kraftwerk Union A. G., Erlangen (F. R. Germany)). Tech. Mitt.; 68: No. 1/2, 22-36(1975). (In German).

The development of unit power in conventional and nuclear

power stations in Germany and the USA is reviewed. The development of design criteria for conventional and reheat turbines is analyzed. A survey is presented of constructional types and problems of conventional reheat turbines by the example of turbine types for 150, 300, 600 and 1,200 MW. Saturated steam turbines for boiling-water and pressurized-water reactors are described. Maintenance, automatics, and turbine protection systems are outlined. Reliability and availability are discussed. (GE)

**30416** BEHAVIOR OF FUEL ROD CLADDING AND CORE COMPONENT MATERIALS DURING AND AFTER IRRADIATION. Closs, K. D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Atomwirtsch., Atomtech.; 20: No. 5, 262-263(May 1975). (In German).

From European conference on irradiation behaviour of fuel cladding and core component materials; Karlsruhe, F. R. Germany (3 Dec 1974).

The interest of most of the current investigations is focussed on austenitic steels. As it is not clear whether this group of materials can meet the demands made on fuel rod claddings and core components of industrial breeder reactors, ferritic steels and nickel base alloys are regarded as back-up solutions and taken into consideration in the investigations. Central issues of the papers were pinholing under radiation, the influence of radiation on the structural stability, and mechanical properties during and after irradiation. (GE)

**30417** STEAM TURBINES FOR NUCLEAR POWER PLANTS. Zwahr, H. (Technische Univ. Hannover (F. R. Germany). Inst. fuer Stroemungsmaschinen). Kerntechnik; 17: No. 3, 119-127(Mar 1975). (In German and English).

This paper discusses the role of steam turbine construction in modern nuclear power plant engineering. The basic thermodynamics of the steam cycle of various nuclear power plant types are presented and discussed. The differing live steam data necessitate different steam turbine designs. The saturated or wet steam turbines used with light water reactors are discussed in detail. (auth)

**30418** EXPERIENCE FOCUSES ATTENTION ON DETAILS OF IN-SERVICE INSPECTION IN NUCLEAR PLANTS. Birkle, A. J. Power (N. Y.); 119: No. 9, 104-105(Sep 1975).

Requirements of Section XI of the ASME Boiler Code are illustrated, and suggestions are presented for planning of pressurized component inspection procedures. (DG)

**30419** IMPACT OF ASME SECTION III. Branch, E. B. Power (N.Y.); 119: No. 10, 23-27(Oct 1975).

A discussion is presented of the requirements imposed on design, procurement, materials, and fabrication of reactor components including pressure vessels, tanks, piping, valves, pumps, reactor vessel internals, and component supports. (DG)

**30420** ACTIVITY CONTROL SYSTEM. Hiller, S.; Schad, H. (to Kraftwerk Union AG). German(FRG) Patent 2,331,209/A/. 16 Jan 1975. 3p. (In German).

The paper describes an activity control system for gases in nuclear facilities, in particular for the monitoring of iodine in the exhaust air. Gas outlet tubes of a polytetrafluoroethylene with an earthed jacket lead to a common point of measurement and evaluation. (GE)

**30421** RADIATION MEASURING SYSTEM FOR NUCLEAR FACILITIES. Rinn, F. (Siemens A. G., Karlsruhe (F.R. Germany). Systemtechnische Entwicklung). Siemens-Z.; 48: No. 9, 617-621(Sep 1974). (In German).

The system for neutron flux density measuring and radiation control consists of constructional parts with optimized partial functions. This design facilitates the construction of instrument holes to solve all technical problems of neutron and radiation measurement. The components include a dc amplifier with an extended logarithmic range of $10^{-13}$ to $10^{-3}$ A and a differential measuring instrument with logarithmic indication for "Curie measurements". As the constructive design of the constructional parts corresponds to the system TELEPERM C, both systems are compatible with regard to signals and assembling. (GE)

**30422** NUCLEAR REACTOR WITH A SHIELD WALL BETWEEN HEADER SPACE AND PRESSURE VESSEL WALL. Swars, H. (to Internationale Atomreaktorbau GmbH). German(FRG) Patent 2,346,868/A/. 20 Mar 1975. 13p. (In German).

4 figs.

A liquid cooled reactor is described in which the heated coolant coming out of the reactor core is collected above the core in a space at a distance from the pressure vessel wall, which is formed by a shield wall arranged inside the pressure vessel. The heated coolant is directly sucked out of the header space in the suction pipes of the main cooling circuit. Due to the arrangement, the annular gap arising between the shield wall and the pressure vessel wall is used by the arrangement of other heat-sensitive components. The arrangement of suction branches, suction pipe, and heat exchanger is described. (GE)

**30423** CALANDRIA VESSELS. Martin, D. J. V. (to United Kingdom Atomic Energy Authority). British Patent 1,396,705/B/. 4 Jun 1975. Filed date 29 Sep 1971. 3p.

Reference is made to calandria vessels for nuclear reactors. Such vessels have been manufactured from Al–Mg alloy, which is a low neutron absorbing material but which has a relatively low tensile strength, for which reason there is a risk that, in service, the calandria tubes may be damaged for example by "missiles" propagated by a damaged coolant conducting tube, with the loss of expensive moderator material, such as heavy water. It has been proposed to fabricate the vessels from Zr alloy, which is stronger than Al–Mg alloy, but is much more expensive. In the calandria vessel described the tubes are reinforced by cladding externally with a tube comprised of Zr alloy, Ti alloy or Be alloy. These materials are of high strength and low neutron absorption. Zr alloy is preferred. The reinforcing tubes are thermally shrunk onto the calandria tubes. (UK)

**30424** BURSTING SAFEGUARD FOR LARGE CYLINDRICAL VESSELS. Daublebsky, P. (to Kraftwerk Union AG). German (FRG) Patent 2,349,518/A/. 24 Apr 1975. 9p. (In German).

2 figs.

A bursting safeguard for reactor pressure vessels is described which provides favorable transport possibilities and allows easy assembly. (GE)

**30425** FINITE ELEMENTE ZUR BERECHNUNG VON SPANNBETON-REAKTORDRUCKBEHAELTERN. (Finite Elements for the Calculation of Prestressed Concrete Reactor Pressure Vessels). Argyris, J. H.; Faust, G.; Roy, J. R.; Szimmat, J.; Warnke, E. P.; William, K. J. (Stuttgart Univ. (TH) (F. R. Germany)). Deutscher Auschuss fuer Stahlbeton. Berlin; Ernst (1973). 69p. (In German).

89 figs.; 75 refs.

The underlying finite element theory, associated software design concepts, and application of the program system SBB for the analysis of prestressed concrete reactor vessels are presented. Basic concepts of the finite element method are reviewed in regard to the analysis of three-dimensional composite solids. Different finite elements at disposal for idealisation of various structural components in a prestressed concrete reactor vessel within the scope of three-dimensional, planar or axisymmetric analysis are discussed. Programming aspects and the user-oriented side of the method are considered. Description of the program and data organisation is followed by a summary of the Choleski equation solver using hypermatrices and substructures. Program usage and the pertinent input-output facilities are briefly presented. Capabilities of the program for the solution of technical problems are illustrated. A number of examples serve to document its diverse applicability including an extensive study of the THTR 1:5 scale pressure vessel model. (auth)

**30426** ANALYSIS OF MODERATELY THICK FLANGED REACTOR VESSELS. Goldberg, J. E.; Pathak, D. V.; Yang, H. T. Y. (Purdue Univ., Lafayette, Ind. (USA)). Nucl. Eng. Des.; 32: No. 3, 363-381(1975).

A computer method is presented for the analysis of moderately thick flanged shells of revolution such as are used for reactor pressure vessels. The shell may be subjected to symmetrical or unsymmetrical loads and a thermal environment. The method employs a finite element discretization for modelling the flange portions, and a theory appropriate to moderately thick shells for the remainder of the pressure vessel. The governing differential equations for the shell portions are put in the Goldberg–Bogdanoff first-order form and integrated numerically using a scheme such as a Runge–Kutta process. The finite element stiffness matrix for a flange region is used to form a superelement influence coefficient matrix, permitting the flange region to be treated as a giant step in the numerical integration process. (auth)

**30427** PRESSURES DUE TO POST-TENSIONED TENDONS ON A DOME OF A NUCLEAR REACTOR CONTAINMENT VESSEL. Choo, Y. I. (Bechtel Corp., San Francisco, Calif. (USA)). Nucl. Eng. Des.; 32: No. 3, 386-393(1975).

An approximate method is derived for analyzing forces and pressures due to post-tensioned tendons on a dome. The dome can possess any axisymmetric shape. Loss of prestress due to friction is taken into account. Use of the method is demonstrated for a sphere-torus dome, and typical distribution of pressure is presented. (auth)

# Reactor Fuels

*Refer also to abstracts 27679, 28370, 28371, 28379, 28421, 28422, 28424–28429, 28435, 28439–28441, 28457, 28459, 28484, and 28610.*

**30428** (FEI-512) CALCULATION TECHNIQUE FOR INTERCHANNEL MIXING EFFECT ON THE COOLANT TEMPERATURE FIELD IN FUEL ASSEMBLIES WITH WIRE-WRAP SPACERS. Zhukov, A. V.; Sorokin, A. P.; Titov, P. A.; Ushakov, P. A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1974. 20p. (In Russian). INIS.

A method is proposed for calculating the heating of the coolant in a reactor fuel element cartridge with wire-wrap spacers and a finned shell. In the calculation, account is taken of interchannel exchange by the wire winding (forced mixing) and by heat conduction of the coolant. For the two approaches to the calculation of forced exchange—effective and local model—a ratio is given for calculating the coefficients of interchannel transfer. The results of numerical calculation of coolant heating in a reactor fuel cartridge BN-600 are presented. (tr-auth)

**30429** (JUL-1200) CONTRIBUTION TO THE DEVELOPMENT OF A COATED PARTICLE FUEL ELEMENT COOLED DIRECTLY BY WATER. Katscher, W. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Nukleare Sicherheitsforschung). Jun 1975. 117p. (In German). Dep. NTIS (US Sales Only) $9.00.

Thesis. Submitted to Technische Hochschule, Aachen.

Studies are described of the utilization of coated particles in fuel elements of nuclear reactors cooled by water. This is done using the example of development work on a fuel element for the Juelich research reactor FRJ-2. To provide optimum cooling of the particles, it is intended to arrange them as a packing which is directly traversed by water. Problems of heat transfer and fluid flow are dealt with. By means of burnout experiments using induction heating it is demonstrated that it is possible to cool packings of spheres directly by water even at high power densities — in the present case up to 3.28 kW/cm$^3$ packing volume. The optimum particle diameter is close to 0.6 mm. According to the results of an endurance test mechanical abrasion of the outer SiC coating layer of the particles in a packing passed through by water is no problem. On the other hand safety problems concerning the consequence of local clogging or fracture of the packing jacket or problems concerning the emergency core cooling have to be solved. (auth)

**30430** HEAT TRANSFER PROPERTIES OF FUEL PINS DETERMINED BY NOISE ANALYSIS. Robinson, E. (Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). pp 133-143 of Thermodynamics of Nuclear Materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974). See STI/PUB-380(Vol.1); CONF-741030-P1.

A measuring method is presented by which the heat transfer constants of fuel pins, inserted in a nuclear light water reactor, are determined by cross-power spectral density measurements, utilizing reactor noise. The phase of a measured transfer function between reactor power fluctuations and the signal of a high temperature thermocouple in a fuel pin is interpreted by a point model of the temperature dynamics of the fuel rod. The effect of the thermocouple time constant is also considered. The model is shown to be adequate in the frequency region analyzed. (auth)

**30431** NUCLEAR REACTOR FUEL ROD WITH A TUBE CONTAINING FISSILE MATERIAL. Duncan, R.; Barna, R. P. (to Westinghouse Electric Corp.). German(FRG) Patent 2,444,562/A/. 27 Mar 1975. 11p. (In German).

3 figs.

A device is described to manipulate a fuel rod one end of which contains an opening which can be closed by welding the end gasket after letting in a gas under pressure. The device has a gas-tight end and allows a turn of the fuel rod during welding. (GE)

**30432** THEORETICAL MAGNITUDE OF THE STRESSES PRODUCED IN FUEL CLADDING BY THE EXPANSION OF CRACKED PELLETS: EFFECT OF INTERFACIAL DISLOCATIONS (INTERFACEONS) AND PELLET RELAXATION. Gittus, J. H. (UKAEA Reactor Group, Springfields). Nucl. Eng. Des.; 32: No. 3, 358-362(1975).

Because the stresses to which metals are subjected in service are a much smaller proportion of the elastic modulus than are the stresses commonly imposed on rubbery polymers, the coefficient of friction when interfacial dislocations (interfaceons) are present is much lower for metals than for rubber. It is also much lower than the coefficient of friction for ordinary sliding (in the absence of interfaceons) and so the stress concentration predicted to be produced by pellet cracks is negligible if there are interfaceons present. If they are absent then the stress concentration is significant. In either case a low rate of power increase causes the lowest stresses and stress concentrations in the clad. This is shown to be due to relaxation creep in the pellet. (auth)

**30433** NONLINEAR DYNAMIC ANALYSIS OF A STACKED FUEL COLUMN SUBJECTED TO BOUNDARY MOTION. Lee, T. H. (General Atomic Co., San Diego, Calif. (USA)). Nucl. Eng. Des.; 32: No. 3, 337-350(1975).

A method has been developed for analyzing the nonlinear dynamic response of a column consisting of stacked elements excited by boundary motions. The elements are constrained by dowel pins which restrict relative horizontal movement but allow vertical and rocking motions between elements. Two different models have been considered. In the first, the dowels are treated as rigid shear connectors, and equations of constraint are used in conjunction with Lagrange multipliers. In the second, the dowels are considered as flexible items. Horizontal slipping at the element-to-element interface is permitted, the Coulomb friction is considered at the contact point. Example problems were solved using both models, and numerical results are presented for the free vibrations of short columns and the boundary-excited response of tall columns. (auth)

# Reactor Control Systems

*Refer also to abstract 28020.*

**30434** (AECL-5102) ADDITIONAL SHUTOFF ROD EXPERIMENTS IN ZED-2. Okazaki, A.; Jones, R. T. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Mar 1975. 36p. Dep. NTIS (US Sales Only) $5.00. AECL $1.00.

Measurements were made of the interaction of two absorbers or shutoff rods separated by one lattice pitch (27.3 cm). The curved plate and channel absorbers studied in earlier experiments (AECL-4831) were used. The reactivity effects were determined by critical height and period measurements. Flux distributions on the absorber surface and throughout the reactor core were obtained. 5 references. (auth)

**30435** (AED-CONF-73-434-004) OVERALL PLANT CONTROL AT BRUCE GENERATING STATION. Fieguth, W. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects). 1973. 17p. (CONF-731233-3). INIS.

From conference on automatic control; Fredericton, New Brunswick, Canada (24 Sep 1973).

The overall plant control system at the Bruce Nuclear Power Station consists of an integrated set of digital computer programs controlling reactor flux power, boiler pressure, and generator electrical output. For reasons of grid system stability a reactor-following-turbine control scheme was adopted, a departure from earlier base-load nuclear stations which were of the turbine-following-reactor design. The plant and control system design are described and simulation results of typical transient responses are presented. (auth)

**30436** (AED-CONF-73-434-006) CONTROL SYSTEMS DESIGN AND OPERATING EXPERIENCE IN THE PROTOTYPE GENTILLY-1 NUCLEAR POWER STATION. Hinchley, E. M. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects). 1973. 12p. INIS.

From Canadian conference on automatic control; Fredericton, New Brunswick, Canada (24 Sep 1973).

Two control problems which were encountered in design and operation of the prototype Gentilly-1 Nuclear Power Station are described. The first problem was to control the water level in the steam drums. Analysis and simulation at the design stage indicated the presence of a non-minimum phase effect which made conventional control impossible under certain conditions of operation. This led to the design of a non-linear computer operated controller incorporating feedforward action from the reactor. Operation of this controller has been essentially as predicted. The second problem was to control the three-dimensional distribution of power in the reactor using finite control rods and a limited number of distribution measurements. Because of a lack of adequate multi-dimensional dynamic models during the design stage, the form of the controller was based largely on intuition and designs used in other nuclear power plants, and back up by appropriate simple analysis. Actual plant operation pointed to deficiencies and led to significant modifications in the controller. Operating experience with the plant rather than simulation was

the key to identifying the design problems and requirements. (auth)

**30437** (ANL-CT-74-10) PROPOSAL FOR THE DEVELOPMENT OF SELF ACTUATED SHUTDOWN SYSTEMS FOR LMFBR PLANTS. (Argonne National Lab., Ill. (USA)). Apr 1974. 85p. AT.

This proposal deals with a reactor component which will improve LMFBR scram reliability to the level of less than $10^{-7}$ failures/demand as currently required by the Regulatory branches of the AEC for water cooled power reactors. A system is suggested which is entirely self-contained, requiring no external electrical or mechanical connections, which will act to shutdown the reactor spontaneously. The system is actuated by the accident itself, and is virtually immune from electro-mechanical malfunction, human error, or deliberate intervention. This proposal includes a preliminary examination of the possible poison materials, triggering devices, insertion mechanisms, and other components that could be used in such an Inherent Shutdown Assembly (ISA). The kinds of accidents that might occur, and the response of an ISA device are explored. (25 references) (auth)

**30438** (ANL-CT-74-19) DEVELOPMENT OF SELF-ACTUATED SHUTDOWN SYSTEMS FOR LMFBR PLANTS. Final Report. (Argonne National Lab., Ill. (USA)). Jul 1974. 101p. AT.

Technical progress and administrative developments in the program for development of self-actuated LMFBR shutdown systems are reported. (JWR)

**30439** (ANL-CT-76-2) DEVELOPMENT OF SELF-ACTUATED SHUTDOWN SYSTEMS FOR LMFBR PLANTS. Final Report. Josephson, J.; Huebotter, P. R.; Sowa, E. S.; van Erp, J. B.; Pizzica, P. A.; Barthold, W. P.; Turski, R. B.; Schumar, J. F.; Parr, E. D.; Eggen, D. (Argonne National Lab., Ill. (USA)). Aug 1975. 190p. AT.

The further development during FY 1975 of the Self-Actuated Shutdown System (SASS) for LMFBR plants carried out at ANL is presented. A ferromagnetic Curie temperature permanent magnet holding device has been selected as the basis for the design of the Inherent Shutdown Assembly (ISA) of the SASS. The self-actuated self-contained device operates such that accident conditions, resulting in increased coolant temperature or neutron flux reduce the magnetic holding force by raising the temperature of the trigger mechanism above the Curie point. Boron carbide absorber is then inserted into the core, under gravity, terminating the accident. Magnetic and thermal-hydraulic analyses have been performed which show the feasibility of the concept with respect to response time, holding force, and coolability. ISA absorber worths have been estimated in the physics analysis. These have been shown to be sufficient to protect against severe reactor transients such as loss of flow and fast reactivity excursions in an accident analysis. The presence of the absorber material in the upper axial blanket region of a CRBR type core has been shown to have a minimal impact upon core performance. Fissile source and radiation induced heat generation calculations were also carried out in the physics analysis. An experimental program has also been performed which has demonstrated proof of principle of the selected Curie point magnetic hold device. As part of this program, experiments were carried out in air and in static sodium. Several of the materials aspects of the SASS design have been examined and discussed particularly with respect to the possible problem areas. (auth)

**30440** (GA-A-13485) GAS TURBINE HTGR PROGRAM. Semiannual Progress Report for the Period January 1, 1975–June 30, 1975. (General Atomic C., San Diego, Calif. (USA)). 28 Jul 1975. Contract AT(04-3)-167. 268p. Dep. NTIS $7.60.

Progress is reported in investigations of reactor plant systems and dynamics, plant safety, the primary pressure boundary, turbo-machinery technology, materials, fission product effects, and requirements for the Helium Component Test Facility (HCTF). The adoption of SK-169 as the reference design configuration on January 27, 1975 necessitated precise and detailed analyses of the new configuration's performance characteristics. Results from performance analyses are presented. (auth)

**30441** (HEDL-TME-75-83) SCRAM: A COMPUTER PROGRAM FOR CALCULATING SCRAM TIMES FOR LMFBR CONTROL RODS. Bourquin, R. D.; Birney, K. R. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-2170. 33p. AT.

Prediction of scram times is an important aspect of design analysis for control rod assemblies. The SCRAM computer program permits design analysis of control rod assemblies for FFTF and could be easily modified for application to other control rod systems. Results obtained using the SCRAM model are compared with experimental results. (5 references) (auth)

**30442** (RN-DR-0080(Vol. 2)) NERVA PROGRAM STATUS REVIEW, SACRAMENTO, CALIFORNIA. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1966. Contract SNP-1. 286p. Dep. NTIS $17.50.

Declassified 27 Sep 1975.

Material presented at a program status review has been documented. It is mainly concerned with the XE-PRIME, NERVA, and PHOEBUS-2A reactors and considers mostly design and planning with emphasis on nozzles, turbopumps (and their bearings), valves, control systems, and test facilities. (LTN)

## Nuclear Power Plant Economics

*Refer also to abstracts 30217 and 30340.*

**30443** (BNL-20398) NOTE ON THE SIGNIFICANCE OF SYNTHETIC FUELS AND THE ROLE OF NUCLEAR ENERGY AS A SOURCE OF SUPPLY. Steinberg, M. (Brookhaven National Lab., Upton, N. Y. (USA)). Jun 1975. 20p. Dep. NTIS $4.00.

The long term need for synthetic hydrocarbon fuels is examined. The role of coal and nuclear energy in producing synthetic fuels is discussed. (JWR)

**30444** (INIS-mf-1372) NUCLEAR POWER: FUTURE INSTALLATIONS AND MATERIALS REQUIREMENTS. Russell, S. H. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects). Jan 1974. 16p. (CONF-7404113-1). INIS.

From annual meeting of the institute of mining and metallurgy; Montreal, Quebec, Canada (21 Apr 1974).

The total installed capacity of Canada's nuclear generating stations, which was 2500 MW(e) at the end of 1973, is expected to increase to more than 100,000 MW(e) by the year 2000. Most of these stations will be located in Ontario and Quebec. The distribution of costs for the construction and operation of a typical nuclear generating station are discussed. These data are then combined with the forecast installation of new stations to arrive at an estimate of the distribution of the total expenditures to be made for nuclear power up to the year 2000. (auth)

**30445** (INIS-mf-1715) NUCLEAR ENERGY AS A REAL BUT PARTIAL ALTERNATIVE IN THE SOLUTION OF ENERGY PROBLEMS IN ISRAEL IN THIS CENTURY. Adar, I. (Israel Atomic Energy Commission, Tel Aviv). Sep 1974. vp. (In Hebrew). INIS.

From national symposium on energy; Natanya, Israel (19 Mar 1974).

Published in "The National Symposium on Energy, Netanya, Israel, 19-21 Mar 1974," ed. by Perath, I., Ministry of Commerce and Industry, Jerusalem (Israel); Natural Resources Research Administration, Israel, Sep 1974, p. 58-67.

The reasons for the world nuclear power plants increase from 170 units—65,000 MeV at the beginning of 1974—to 340 units in operation or under construction at the end of the year, with a future total output of 200,000 MeV, are given. For Israel especially, nuclear power is the only alternative; but it will cover at the best only 40–50% of all energy needs up to the end of this century and the same applies to almost all other developed countries. After enumerating the steps already taken in Israel in the field of nuclear power, the two reasons that had prevented up to now the construction of nuclear plants—the small dimensions of the electric network and the fact that Israel is located in the area with the largest oil reserves in the world—are detailed. Those reasons are not valid anymore. The crude which now reaches an average of $80/t will go down toward 1980 to $40–60/ton, and this last price of crude should be considered when looking for alternatives. Although the costs of nuclear energy will also rise, the differences between $26/t price, at which nuclear power becomes competitive and $40–60/t for crude fully justifies the construction of nuclear power plants. The more so when dual-purpose electric power desalting plants for Israel are contemplated. The conclusion is that the construction of nuclear power plants in general and in Israel, in particular with the addition of a certain percentage of gas turbine energy for peak needs, is the solution for the next decade. (INIS)

**30446** (STI/PUB-395) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES, 1974 EDITION. (International Atomic Energy Agency, Vienna (Austria)). Oct 1974. 32p. Unipub, Box 433, Murray Hill Station, New York, NY 10016 $3.00.

A revision is presented of a previous evaluation of the market for nuclear power in developing countries. (JWR)

**30447** ENERGY EXPENDITURE INVOLVED IN BUILDING AND OPERATING NUCLEAR POWER PLANTS. Bald, M.

(Kraftwerk Union A. G., Erlangen (F. R. Germany)); Harig, H. D. (Rheinisch-Westfaelisches Elektrizitaetswerk A. G., Essen (F. R. Germany)); Voss, A. (Kernforschungsanlage Juelich G. m. b. H. (F. R. Germany)). Atomwirtsch., Atomtech.; 20: No. 6, 296-297(Jun 1975). (In German).

In the public discussion about the economic benefits of nuclear power it was argued recently that more energy was required to build and operate nuclear power plants than would be generated by those plants. Three authors, one of them working at a nuclear research center (KFA Juelich), one with a utility (RWE), and one with a reactor manufacturer (KWU), have studied this question. It is seen that the energy expenditure is roughly the same for a coal fired power plant and a nuclear power plant and that all the energy needed to build a nuclear power plant can be "recovered" in one month of full power operation. (auth)

**30448** NUCLEAR ENGINEERING AT THE NINTH WORLD ENERGY CONFERENCE. A Review. Arch. Energiewirtsch.; 29: No. 5, 465-484(May 1975). (In German).

From 9th world energy conference; Detroit, Mich. (23 Sep 1974). 7 tabs.; 26 refs.

Groups of reports on various aspects of nuclear energy are summarized. The issues are: standards and forecasts on future developments in nuclear power industry; the importance of the fast breeder for the structure of nuclear power industry; alternatives in the construction of nuclear power stations; experience in the construction and operation of nuclear power stations; new reactor types and designs; the nuclear fuel cycle; and the environmental impact of nuclear energy. (GE)

**30449** UNCERTAINTIES AND RISKS OF NUCLEAR POWER DEVELOPMENT IN THE USA. Posner, E. Glueckauf; 111: No. 9 No. 9, 453-455(May 1975). (In German).

On the basis of a NERA study a survey of the present problems of development is given. The issues are realization of planned nuclear power stations, fast breeder development, radioactive waste disposal, uranium enrichment, and the supply of natural uranium. (GE)

**30450** INVESTMENT IN THE ELECTRICITY ECONOMY OF THE USA. A Survey. Arch. Energiewirtsch.; 29: No. 4, 365-368(Apr 1975). (In German).

The basic captial of the USA electricity economy is estimated to be about 140 to 150 billion dollars with a total installed power plant capacity of about 420 GW. The structure of the capital investment is given in tables and more closely explained in the text, a) (1965-1973) in the power plants, the transmission lines and distribution networks as well as b) (1973) in the various types of power plants (thermal power, nuclear power, gas turbine, hydraulic power, pumped storage) depending on the various supporting societies or institutions (private societies, town or state administrations, cooperative societies, federal authorities). In the financial year 1973/74, the federal means reached 850 million dollars for financing the energy economy. (GE)

**30451** ELECTRICITY SUPPLY ECONOMY FROM THE STANDPOINT OF THE ENERGY CRISIS. Niehage, G. (Vereinigte Elektrizitaetswerke Westfalen A. G. (VEW), Dortmund (F. R. Germany)). Elektrizitaetswirtschaft; 74: No. 1, 255-260(May 1975). (In German).

The author reports on how the application of primary energy in electricity supply after the preceding price crisis for natural oil, which had hardly any effect on electricity supply, will develop in the future. The measures in the third electricity supply law as well as the ideas behind the projected energy programme of the Federal Government, to base electricity supply more on home-produced coal, are reviewed critically. In the long term electricity supply is ensured only on the basis of nuclear energy, which gives relative price stability for electrical energy and at the end of the eighties will be in a position, as a source of process heat for coal conversion processes, to reduce the dependence of the Federal Republic on imported hydrocarbons. (auth)

**30452** SPECIAL CONDITIONS FOR POWER SUPPLY IN SOUTH GERMANY. Heitzer, H. (Bayerisches Staatsministerium fuer Wirtschaft und Verkehr, Muenchen (F. R. Germany)). Elektrizitaetswirtschaft; 74: No. 1, 260-263(May 1975). (In German).

From DK-EW/VDEW-Electroheat meeting; Muenchen, F. R. Germany (15 Apr 1975).

The author discusses the special problems in power supply in South Germany from the point of view of administration of the economy in Bavaria. He describes the problems which arose after the power crisis in autumn 1973. (auth)

**30453** ROLE AND IMPORTANCE OF NUCLEAR ENERGY IN THE FULFILLMENT OF ENERGY NEEDS. Paris; Commissariat a L'Energie Atomique (1975). 23p. (In French).

From 1st European nuclear conference on the coming of age of nuclear energy; Paris, France (21 Apr 1975).

The economic competitiveness of nuclear energy with respect to fossil fuel, particularly since the petroleum crisis, for the production of electricity, steam, and process heat is illustrated graphically. A pattern for the development of nuclear energy, based on an analysis of the world's energy needs and the depletion of fossil fuels, is derived. The effect of the introduction of high-temperature reactors and breeders on this development pattern is considered. (JSR)

**30454** COMPETITIVENESS AND RANGE OF APPLICATIONS OF NUCLEAR POWER, AS SEEN IN THE LIGHT OF RECENT DEVELOPMENTS IN THE FIELD OF ENERGY ECONOMIC AND ENERGY POLICY. Michaelis, H. (Koeln Univ. (F. R. Germany). Energiewirtschaftliches Inst.; Commission of the European Communities, Brussels (Belgium)). Elektrizitaetswirtschaft; 74: No. 11, 325-330(May 1975). (In German).

From reactor conference; Nuernberg, F. R. Germany (8 Apr 1975). 17 tabs.

The competitive position of nuclear energy in the German Federal Republic and the determining factors in cost development, both for conventional energy generation and for nuclear power generation, are discussed. (GE)

**30455** CONSIDERATIONS ON THE APPLICATION OF ENERGY IN THE GENERATION OF ELECTRICITY AND HEAT. Koch, H. (VEBA-Kraftwerke Ruhr A. G., Gelsenkirchen (F. R. Germany)). Elektrizitaetswirtschaft; 74: No. 11, 309-316(May 1975). (In German).

From 28th general meeting of the Vereinigung Deutscher Elektrizitaetswerke; Duesseldorf, F. R. Germany (22 Apr 1975). 17 figs.

The main factors influencing electricity generation costs in fossil-fuel power stations and their development since 1950, are reviewed. The probable energy sources for different types of power stations are examined with special attention to nuclear stations and their possible use in power-heat combinations. The necessary district-heating systems and their costs are discussed. The overall costs of the various heating systems at present available are analyzed. (auth)

**30456** ENERGY SUPPLY IN A CLOSED CYCLE. Schulten, R.; Barnert, H. VDI (Ver. Dtsch. Ing.) Ber.; No. 224, 25-35 (1974). (In German).

4 figs.

As it provides an economical, sufficient and safe energy supply, nuclear energy must be used in future to a greater extent, in particular on the market for heat energy. It is thus necessary to convert nuclear energy into readily applicable forms of energy. A suitable conversion process for this purpose is the EVA/ADAM system which transports nuclear energy in the form of latent chemical energy and converts it into the ready-to-use forms of energy-hot water and steam. The energy transport with this system takes place in a closed cycle. (GE)

## Reactor Fuel Cycle Economics

**30457** INTERNATIONAL STRUCTURES OF THE NUCLEAR FUEL CYCLE. Schmidt-Kuester, W. J. (Bundesministerium fuer Forschung und Technologie, Bonn (F. R. Germany). Abt. Energieforschung und -technologie). Atomwirtsch., Atomtech.; 20: No. 6, 282-288(Jun 1975). (In German).

From reactor conference; Nuernberg, F. R. Germany (8 Apr 1975). 9 figs.

The degree in which the nuclear fuel cycle has become operational in the Western world as a whole and in the Federal Republic of Germany in particular varies greatly. The survey shows that the supply sector, including the enrichment complex, seems to be complete. In the field of fuel element fabrication there seems to be overcapacity, or it could well emerge in the implementation of present plans. Some problems do exist in the waste management sector, especially in reprocessing where capacity expansion greatly lags behind estimates and will require considerable storage facilities for spent fuel elements to be set up by 1985. This underrun in capacity evolved without any correction being made to the nuclear power programs, merely as a result of delays in the completion and commissioning schedules of existing projects. Plutonium recycling and the treatment and storage of radioactive wastes have made satisfactory progress both in research and development and will be further improved by extensive additional experimental programs. (auth)

# Reactor Licensing and Regulation

**30458** (DOCKET-50289-468) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Semiannual Operating Report No. 3, January–June 1975. (Metropolitan Edison Co., Reading, Pa. (USA)). 2 Sep 1975. 49p. Dep. NTIS $5.50.

Information is presented concerning power generation, shutdowns, corrective maintenance, chemistry and radiochemistry, occupational radiation exposure, release of radioactive materials, abnormal occurrences, FSAR changes, and refueling information. (FS)

**30459** (DOCKET-50293-500) PILGRIM NUCLEAR POWER STATION, UNIT 1. Semiannual Operating and Maintenance Report No. 6, January–June 1975. (Boston Edison Co., Mass. (USA)). 30 Aug 1975. 38p. Dep. NTIS $5.00.

Net electrical power generated was 1,505,728 MWH with the reactor on line 3295.2 hours. Information is presented concerning power generation, shutdowns, corrective maintenance, chemistry and radiochemistry, occupational radiation exposure, release of radioactive materials, and abnormal occurrences. (FS)

**30460** (INIS-mf-1700, pp 15-21) TASKS OF THE STATE INSPECTION IN SAFEGUARDING THE SAFETY OF NUCLEAR FACILITIES. Klik, F. 1974. (In Czech).

From nuclear heating and containments; Brno, Czechoslovakia (3 Oct 1973).

In nuclear heating and containment. Supplement. (Ceskoslovenska Komise pro Atomovou Energii, Prague).

The tasks are listed of the State Inspection (charged with this responsibility in Czechoslovakia is the Czechoslovak Atomic Energy Commission) in safeguarding nuclear facilities, such as the formulation of criteria, recommendations, and guidelines for reactor safety. The evaluation of safety on which the licensing of nuclear power installations construction is conditional, the program of safeguarding quality and of quality inspection as part of the licensing process, the observance of license conditions, and the incorporation of legal aspects of reactor safety in the Czechoslovak legal code are discussed. (INIS)

**30461** (NP-20545) QUALITY ASSURANCE PROGRAM. Topical Report, GIBSAR-7. (Gibbs and Hill, Inc., New York (USA)). Sep 1975. 105p. Gibbs and Hill, Inc., New York, NY.

The quality assurance program developed by Gibbs and Hill to satisfy the requirement that design, engineering, procurement, fabrication, and construction activities for nuclear power plants are performed in accordance with applicable codes, standards, and regulatory criteria is outlined. The program was developed to conform to the criteria of Appendix B to 10 CFR Part 50 and is presented in such a manner that each of the 18 criteria are individually set forth. The Gibbs and Hill program, implemented by the procedures of the corporate Quality Assurance Manual also follows the guidelines of the NRC Gray Book, WASH 1283, Rev. 1, May 24, 1974, and Green Book, WASH 1309, May 10, 1974. (auth)

**30462** (NRCI-75/7) NUCLEAR REGULATORY COMMISSION ISSUANCES, JULY 1975. (Nuclear Regulatory Commission, Washington, D. C. (USA)). Sep 1975. 171p. TIC $4.00.

Issuances received from the U. S. Nuclear Regulatory Commission, the Atomic Safety and Licensing Appeal Boards, and the Atomic Safety and Licensing Boards are presented. (DCC)

**30463** (RDT-INDEX-(7-75)) INDEX OF RDT STANDARDS. (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). 31 Jul 1975. 92p. RSO.

**30464** (REG/G-1.8(Rev. 1)(9-75)) PERSONNEL SELECTION AND TRAINING. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Sep 1975. 2p. NUREG.

Paragraph 50.34(b)(6)(i) of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that applications for a license to operate a nuclear power plant include information concerning organizational structure, personnel qualifications, and related matters. This regulatory guide describes a method acceptable to the NRC staff of implementing this portion of the Commission's regulations with regard to personnel qualifications. (auth)

**30465** (REG/G-1.16(Rev. 4)(8-75)) REPORTING OF OPERATING INFORMATION: APPENDIX A TECHNICAL SPECIFICATIONS. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Aug 1975. 14p. NUREG.

The reporting program described in this regulatory guide involves the reporting requirements of Appendix A technical specifications only. In some cases, this program may need to be supplemented or modified because of unique plant design features or other factors. The need for a supplemental or modified program will be determined on a case-by-case basis. (auth)

**30466** (REG/G-1.84(Rev.3)(9-75)) CODE CASE ACCEPTABILITY: ASME SECTION III DESIGN AND FABRICATION. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Sep 1975. 6p. NUREG.

This regulatory guide lists those Section III ASME Code Cases oriented to design and fabrication that are generally acceptable to the NRC staff for implementation in the licensing of light-water-cooled nuclear power plants. (auth)

**30467** (REG/G-1.85(Rev. 3)(9-75)) CODE CASE ACCEPTABILITY: ASME SECTION III MATERIALS. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Sep 1975. 6p. NUREG.

This regulatory guide lists those Section III ASME Code Cases oriented to materials and testing that are generally acceptable to the NRC staff for implementation in the licensing of light-water-cooled nuclear power plants. (auth)

**30468** (REG/G-8.8(Rev. 1)(9-75)) INFORMATION RELEVANT TO MAINTAINING OCCUPATIONAL RADIATION EXPOSURE AS LOW AS IS REASONABLY ACHIEVABLE (NUCLEAR POWER REACTORS). (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Sep 1975. 4p. NUREG.

Paragraph 20.1(c) of 10 CFR Part 20, "Standards for Protection Against Radiation," states, in part, that licensees should, in addition to complying with the limits set forth in that part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in that part as practicable. This guide outlines the information relevant to maintaining occupational doses as low as is reasonable achievable (ALARA) needed by the NRC staff in license applications and safety analysis reports for nuclear power reactors. (auth)

**30469** (REG/G-8.10(Rev. 1)(9-75)) OPERATING PHILOSOPHY FOR MAINTAINING OCCUPATIONAL RADIATION EXPOSURES AS LOW AS IS REASONABLY ACHIEVABLE. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Sep 1975. 3p. NUREG.

Both this guide and Regulatory Guide 8.8, "Information Relevant to Maintaining Occupational Radiation Exposure as Low as is Reasonably Achievable (Nuclear Power Reactors)," deal with the concept of "as low as is reasonably achievable" occupational exposures to radiation. This guide describes an operating philosophy that the NRC staff believes all specific licensees should follow to keep occupational exposures to radiation as low as is reasonably achievable. (auth)

**30470** (REG/G-10.1(Rev.2)(8-75)) COMPILATION OF REPORTING REQUIREMENTS FOR PERSONS SUBJECT TO NRC REGULATIONS. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Aug 1975. 12p. NUREG.

This guide presents a compilation of all reporting requirements applicable to the various types of NRC licensees and other persons subject to NRC regulations, including identification of the proper NRC addressee or addressees and designation of the number of copies required. (auth)

**30471** ACCESS ENGINEERING AND OTHER RELATED PROBLEMS OF NUCLEAR POWER PLANTS. Bennett, W. F.; Greer, A. S. (Southwest Research Inst., San Antonio). Mater. Eval.; 33: No. 9, 227-231(Sep 1975).

Section XI of the ASME Code, Rules for Inservice Inspection of Nuclear Reactor Coolant Systems, stipulates the requirements governing inservice inspection (ISI). When constructing a nuclear power plant, the utility must consider plant design, component design and fabrication, and construction procedures in order to achieve designs providing sufficient access to allow compliance with the ISI requirements. The principal early responsibility of the utility is to establish the overall inservice inspection philosophy which dictates the requirements for access for inspection. Design considerations which must be addressed to provide sufficient access for accomplishment of ISI operations in full compliance with ASME Section XI are described. Included in this discussion are advantages of ID and OD inspection; clearance requirements for vessels, nozzles, and piping; and weld design criteria as related to inservice inspection. (auth)

**30472** SELECTING REACTOR OPERATOR TRAINEES. Buel, W. D.; McKee, P. F. Power Eng.; 79: No. 9, 46-49(Sep 1975).

Reactor operator trainee selection tends to be more effective if tailored to a utility's unique needs, and offers the organization a better chance for compliance with Federal regulations than if selection methods are adopted without benefit of local research. The costs of operator training range from $50,000 to $100,000. The test validity relative to a variety of training grades and performance measures is reviewed. Of interest is the degree to which tests differentiate reactor operators with respect to simulator training grades and performance in simulator operation; forms of evaluation which have become fairly standard throughout the power industry. The tests administered to each individual were selected because of their presumed relevance to training grades, and the aptitude measures are intended to assess an individual's potential to benefit from training. Tests, availability, form, the abilities they measure, and the time limit are described. (MCW)

**30473** NEW WUERGASSEN ORDER. Energiewirtsch. Tagesfragen; 25: No. 5, 220-234(May 1975). (In German).

In the contestation of several partial licenses for the Wuergassen nuclear power station, the Supreme Court of Administration for Nordrhein-Westfalen has dismissed the appeal of the plaintiff. The plaintiff was a private person. The defendants were the licensing authorities, the Minister for Economy, and the Minister fuer Wirtschaft, Mittelstand und Verkehr of Nordrhein-Westfalen. Also summoned was the Preussische Elektrizitaets-AG, Hannover, to whom the contested licenses had been issued. The value in litigation was fixed at DM 10,000. One half of the extra-judicial costs of the summoned was declared repayable. Some of the grounds upon which the judgment was based are presented in detail. (auth)

**30474** KERNREAKTOREN. Sinnbilder. (Nuclear Reactors. Graphical Symbols). Berlin; Beuth (1975). 5p.

This draft chart contains graphic symbols depicting the types of nuclear reactors. They will serve as illustrations for graphical sketches. Important features of the individual reactor types are marked out graphically. The user can combine these symbols to characterize a specific reactor type. The basic graphic symbol is a square with a point in the centre. Functional groups can be depicted for closer specification. If two functional groups are not clearly separated, this is symbolized by a dotted line or a channel. Supply and discharge lines for coolant, moderator and fuel are specified in accordance with DIN 2481 and can be further specified by additional symbols if necessary. The examples show several different reactor types. (GE)

**30475** SAFETY CONCEPT OF THE FEDERAL MINISTRY OF THE INTERIOR REGARDING NUCLEAR INSTALLATIONS. Sahl, W. (Bundesministerium des Innern, Bonn (F. R. Germany). Abt. Reaktorsicherheit und Strahlenschutz). Atomwirtsch., Atomtech.; 20: No. 6, 298-303(Jun 1975). (In German).

From reactor conference; Nuernberg, F. R. Germany (8 Apr 1975). 10 refs.

In its Energy Program the Federal Republic of Germany has outlined a concept designed to ensure the long term continuity of energy supply. The Federal Minister of the Interior defines the basic outlines of safety and licensing policies within which this Energy Program may be implemented. The growing public opposition to nuclear installations makes the implementation of nuclear power not only a technical and administrative, but also a political problem. Even though no license may be granted under the Atomic Law unless the respective safety provisions are met, it is not sufficient to fulfill this condition and expect that these licences may be executed right away. This type of conflict plays a very topical role in the nuclear controversy. The framework outlined by the Federal Minister of the Interior leaves much to the discretion of the public authorities. Under a forthcoming amendment to the Atomic Law, further conditions are expected to be imposed as a prerequisite to the licensing of nuclear installations. (auth)

**30476** BASIC PROBLEMS OF ATOMIC LAW ADMINISTRATION. II. The Licensing of Procedure for Nuclear Power Stations in the USA: Essential Aspects, New Developments and Selected Problems as Compared to German Law. Mahlmann, W. pp 67-176 of Grundprobleme zum Atomrechtlichen Verwaltungsverfahren. Lukes, R. (ed.). Heidelberg; Verlagsges. Recht und Wirtschaft mbH (1974). (In German)

With refs.

A comparative evaluation of the problems of nuclear licensing procedures in the USA and the Federal Republic of Germany is presented with the intention of a summarized discussion of basic concepts, new developments and various specific problems of the US licensing procedures. The study facilitates the understanding of the many details given by the press because of the leading role of the USA in this field, and it also makes a contribution to future reform discussions, to attempts at rationalization and standardization, to the problem of judicial control in the field of legislation on technical safety, and of the function of the public in nuclear licensing procedures. It is concluded that the few general attempts to establish a zoning procedure in conformity with the proposed administrative procedure law do not fully meet the specific demands of the licensing procedures for nuclear facilities. In the long run, however, the concept of zoning should be taken up for nuclear licensing procedures. (GE)

**30477** OFFICIAL REPORT AND MOTION ON THE COMMITTEE FOR INTERNAL AFFAIRS OF THE BUNDESTAG (4. COMMITTEE), CONCERNING THE PROPOSED THIRD BILL AMENDING THE ATOMIC ENERGY ACT FRAMED BY THE FEDERAL GOVERNMENT. Bulletins 7/2183, 7/2538. Bundesrat-Drucksache; No. 7/3125, 1-27(Jan 1975). (In German).

The new bill is to adapt the national atomic energy legislation to the conventions which are to be ratified in conformity with the bill to be drafted after the Paris and Brussels Atomic Liability Conventions. It will also prevent a change for the worse in the national atomic liability legislation and serve to improve national liability in the interest of the peaceful use of nuclear energy. These aims will be accomplished by (1) amendment and supplementation of those provisions of the Atomic Energy Law that are affected by the new conventions to be ratified, (2) full use of the reservations made by the Federal Republic at the time of signature of the conventions, with a view to improving the protection of victims, (3) an upward adjustment of the present maximum amount of liability from DM 500 million to DM 1,000 million, (4) an upward adjustment of the financial security required from the present DM 120 million to DM 500 million, (5) a shift of the present indemnification by the Bund from the present range between DM 120 to DM 500 million to the range between DM 500 to DM 1,000 million, and (6) a regime of compensation for persons residing in the Federal Republic who suffer damage caused by foreign reactors. (GE)

**30478** BASIC PROBLEMS OF ATOMIC LAW ADMINISTRATION. I. Nuclear Power Plant Licensing of Procedures Replanned by Zoning. Lukes, R.; Vollmer, L. pp 13-65 of Grundprobleme zum Atomrechtlichen Verwaltungsverfahren. Lukes, R. (ed.). Heidelberg; Verlagsges. Recht und Wirtschaft mbH (1974). (In German)

With refs.

The principal legal advantages of a zoning board as a special legal institution for the planning of large nuclear power plants are discussed. A final evaluation of legal results tends to demonstrate which constitutional and administrative factors will have to be considered for the final decision. It is concluded that the few general attempts at zoning following the administrative procedure do not quite meet the specific requirements of nuclear licensing procedures. In the long run, however, zoning might prove useful for nuclear licensing. (GE)

# GENERAL AND MISCELLANEOUS

## Information Handling

*Refer also to abstract 27960.*

**30479** (JINR-P10-8901) ALGORITHMS FOR FORMING THE FUNDAMENTAL FILES OF THE IRS OF JINR. Arnaudov, D. D.; Yanev, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1975. 22p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

The fundamental algorithms for forming and updating the information files of the IRS of JINR are described. A method is proposed for the optimal use of the operative memory of the computer during the performance of the algorithms. (auth)

## Law

**30480** (DHEW/FDA-76-8009) FEDERAL/STATE RADIATION CONTROL LEGISLATION, 1974. Miller, L. A. (Food and Drug Administration, Rockville, Md. (USA)). Jul 1975. 38p. GPO.

A review is presented of Federal and State radiation control legislation for calendar year 1974, in Federal-State, subject, and status order. A brief description of each bill introduced in 1974 is included, plus existing laws or statutes governing radiation control. (auth)

## Management

**30481** (AGC-5(Rev.1)) LARGE SOLID BOOSTER ROCKET. Applications Planning. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Mar 1963. 66p. Dep. NTIS $6.50.

Declassified 24 Sep 1975.

The development and performance of Aerojet-General's solid booster rockets is detailed. (LTN)

**30482** (DP-929(Rev.2)(Suppl.3)) PUBLICATIONS, 1972–1974. Hilborn, H. S. (comp.). (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Feb 1975. Contract AT(07-2)-1. 174p. Dep. NTIS $7.60.

This is a compilation of documents that communicate the results of scientific and technical work done at Savannah River. The compilation includes those documents that have been published, documents that have been announced in Nuclear Science Abstracts, and papers that have been presented at technical meetings. The information was compiled by machine methods to produce bibliographic, subject, and author listings. This report updates the information included in DP-929, Rev. 2, Publications, 1951 through 1971 and supersedes Supplements 1. and 2. to that report. The subject listing is arranged alphabetically by key work out of context (KWOC) indexing of the titles. (RWR)

**30483** MAN-POWER IN EUROPEAN NUCLEAR RESEARCH AND NUCLEAR TECHNOLOGY. A Comparative Study in 13 Countries. Rembser, J. (Bundesministerium fuer Forschung und Technologie, Bonn (F. R. Germany)). Atomwirtsch., Atomtech.; 20: No. 4, 171-174(Apr 1975). (In German).

The field covered by the investigation and the different personnel categories (degrees of training) are briefly discussed. The numbers of persons employed in nuclear engineering research and development as well as in national and international organizations are depicted in tables. (GE)

## Mathematics and Computers

*Refer also to abstract 27761.*

**30484** (ITEF-83) STUDY ON VARIOUS VARIANTS OF COMPUTER LINKS AT A PHYSICAL CENTRE. Mikhajlov, O. E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1973. 60p. (In Russian). INIS.

Different systems were studied to determine the optimum connections of a computer from the standpoint of maintenance (holdups in maintenance, maintenance intervals, and cost). Apparatus based on massive servicing theory was used. (tr-auth)

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

# NUCLEAR SCIENCE ABSTRACTS

Volume 32

Numbers 7-12

Abstracts 16694-30484

October-December

1975

Office of Public Affairs

## STAFF OF NUCLEAR SCIENCE ABSTRACTS

**Editor and Production Manager**
David E. Bost

**Assistant Editor**
Lee M. Thompson

**Associate Editors**
M. Catherine Grissom
Robert C. Kelly
Sidney F. Lanier
Henry D. Raleigh
Charles E. Stuber

**Report Evaluators**
John H. Mitchell
Mary H. Newman

**Descriptive Cataloging Specialist**
J. Paul Meredith

**Subject Heading Specialist**
Dora H. Moneyhun

**Corporate Author Specialist**
Clara L. Fox

**Report Number Specialist**
Helen W. White

**Information Specialists**
P. Martin Alexander
E. Ray Bedford
Jane G. Buchanan
D. Lamar Cason
David C. Cunningham
Theodore F. Davis
James R. Dulaney
Stanley D. Frey
Darrell O. Galde
Martha W. Gerrard
Barbara J. Glenn
Everett J. Hoffman
Carolyn D. Houston
Lynda H. Kern
W. Hugh Kinser
Lisbeth C. Lieberman
William D. Matheny
Lorne T. Newman
Jean F. Peckham
Mona H. Raridon
Julia S. Redford
Stanley J. Rimshaw
Jessie W. Rushing
Robert W. Rutkowski
Francis L. Sachs
Lila B. Smith
Polly C. Summers
George H. Thoeming
Helen L. Ward
Lawrence T. Whitehead
Milton O. Whitson
Martha C. Wilson

**Publishing Coordinator**
Charles R. Bruce

**Computer Processing Coordinator**
Noboru Kawakami

**Communication concerning the editorial policy and content of *Nuclear Science Abstracts* should be addressed to the Editor, *Nuclear Science Abstracts*, USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.**

***The Administrator of the Energy Research and Development Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1978.***

# COMPLETE OR PARTIAL COLLECTIONS OF ERDA REPORTS IN COUNTRIES OTHER THAN THE UNITED STATES

**ARGENTINA**
Buenos Aires, Comisión Nacional de Energía Atómica

**AUSTRALIA**
Canberra, National Library of Australia
Sutherland, New South Wales Atomic Energy Research Establishment

**AUSTRIA**
Vienna, International Atomic Energy Agency (IAEA)
Vienna, Zentralbibliothek der Physikalischen Institute der Universität

**BELGIUM**
Brussels, European Atomic Energy Community (Euratom)
Mol-Donk, Centre d'Etude de l'Energie Nucléaire

**BRAZIL**
Rio de Janeiro, Comissão Nacional de Energia Nuclear
São Paulo, Instituto de Energia Atômica

**CANADA**
Chalk River, Ontario, Atomic Energy of Canada, Ltd.
Hamilton, Ontario, McMaster University
Ottawa, National Research Council

**CONGO, REPUBLIC OF**
Kinshasa, Trico Nuclear Center

**DENMARK**
Risö, Danish Atomic Energy Commission

**FINLAND**
Otaniemi, Teknillinen Korkeakoulu

**FRANCE**
Saclay, Gif-sur-Yvette, Centre d'Etudes Nucléaires de Saclay

**GERMANY, WEST**
Karlsruhe, Zentralstelle für Atomkernenergie Dokumentation
Munich, Technische Universität

**GREECE**
Athens, Nuclear Research Center, Democritus Library

**INDIA**
Bombay, Trombay, Bhabha Atomic Research Center Library

**IRAQ, REPUBLIC OF**
Baghdad, Atomic Energy Commission, Nuclear Research Institute

**IRELAND**
Dublin, University College

**ISRAEL**
Yavne, Israel Atomic Energy Commission, Soreq Nuclear Research Centre

**ITALY**
Ispra, Cetis Library
Rome, Centro di Studi Nucleari della Casaccia

**JAPAN**
Tokyo, National Diet Library
Tokai-Mura, Naka-gun, Ibaraki-ken, Japan Atomic Energy Research Institute

**KOREA, REPUBLIC OF**
Seoul, Atomic Energy Research Institute

**MEXICO**
Mexico, D. F., Comisión Nacional de Energía Nuclear

**NETHERLANDS, THE**
Petten, Reactor Centrum Nederland
The Hague, Bibliothek Octrooiraad

**NORWAY**
Kjeller, Institutt for Atomenergi

**PORTUGAL**
Sacavem, Junta de Energia Nuclear

**SOUTH AFRICA, REPUBLIC OF**
Pretoria, Atomic Energy Board Library

**SPAIN**
Madrid, Junta de Energía Nuclear, Ciudad Universitaria

**SWEDEN**
Nyköping, Aktiebolaget Atomenergi Library

**SWITZERLAND**
Zürich, Swiss Federal Institute of Technology

**UNITED KINGDOM**
Boston Spa, Wetherby, Yorkshire, British Library Lending Division
Harwell, Didcot, Berkshire, Atomic Energy Research Establishment

# IN INTERNATIONAL AGENCIES

**EUROPEAN ATOMIC ENERGY COMMUNITY (EURATOM)**
Brussels, Belgium
Ispra, Varese, Italy, Cetis Library

**OECD NUCLEAR ENERGY AGENCY (NEA)**
British Library Lending Division
Boston Spa, Wetherby, Yorkshire, England

**INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)**
Vienna, Austria

UNITED STATES
ATOMIC ENERGY COMMISSION
P. O. BOX 62
OAK RIDGE, TENNESSEE 37830
OFFICIAL BUSINESS

GOV

POSTAGE AND FEES PAID
U. S. ATOMIC ENERGY COMMISSION

U.S.MAIL

ID FEES PAID
T PRINTING OFFICE

U.S.MAIL

XEROX UNIVERSITY MICROFILMS
SERIALS DEPT.
300 N. ZEEB ROAD
ANN ARBOR, MI 48106

1

ERDA CRITICAL REVIEW SERIES

# Particle-Transport Simulation with the Monte Carlo Method

L. L. CARTER and E. D. CASHWELL
Los Alamos Scientific Laboratory

*Published October 1975 by the Technical Information Center, Office of Public Affairs, U. S. Energy Research and Development Administration*

*CONTENTS*

Introduction
Sampling Methods
Mathematical Prescriptions for Simulating Particle Transport
Mechanics of Simulating Particle Transport
Neutron Transport
Photon Transport
Literature Survey

Although typically used to simulate a random process, the Monte Carlo method is frequently applied to problems that do not have a probabilistic interpretation. It thus has become a useful computational tool in all major areas of scientific endeavor. In this review the authors focus on the application of Monte Carlo to particle-transport problems and place special emphasis on neutron and photon transport.

An extensive literature survey is included to help the reader delve deeper into other areas for the use of Monte Carlo in solving special problems and to aid him in investigating entirely different uses of Monte Carlo.

*120 pages, 7 by 9¾ inches, paper binding*
*Library of Congress Catalog Card No. 75-25993 (CIP)*

Available as TID-26607 for $5.45 ($7.95 foreign) from

National Technical Information Service
U. S. Department of Commerce
Springfield, Va. 22161